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**Stevenson**

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(54) **AIR COOLING SYSTEM FOR SEALED ATTIC BUILDING STRUCTURES**

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(51) **Int. Cl.**

| | |
|---|---|
| ***F24F 7/02*** | (2006.01) |
| ***F24F 7/007*** | (2006.01) |
| ***F24F 11/00*** | (2018.01) |

(52) **U.S. Cl.**
CPC .............. ***F24F 7/025*** (2013.01); ***F24F 7/007*** (2013.01); ***F24F 11/0001*** (2013.01); *F24F 2221/14* (2013.01); *F24F 2221/16* (2013.01)

(58) **Field of Classification Search**
CPC ......... F24F 7/025; F24F 7/007; F24F 11/0001
USPC .......................................................... 454/349
See application file for complete search history.

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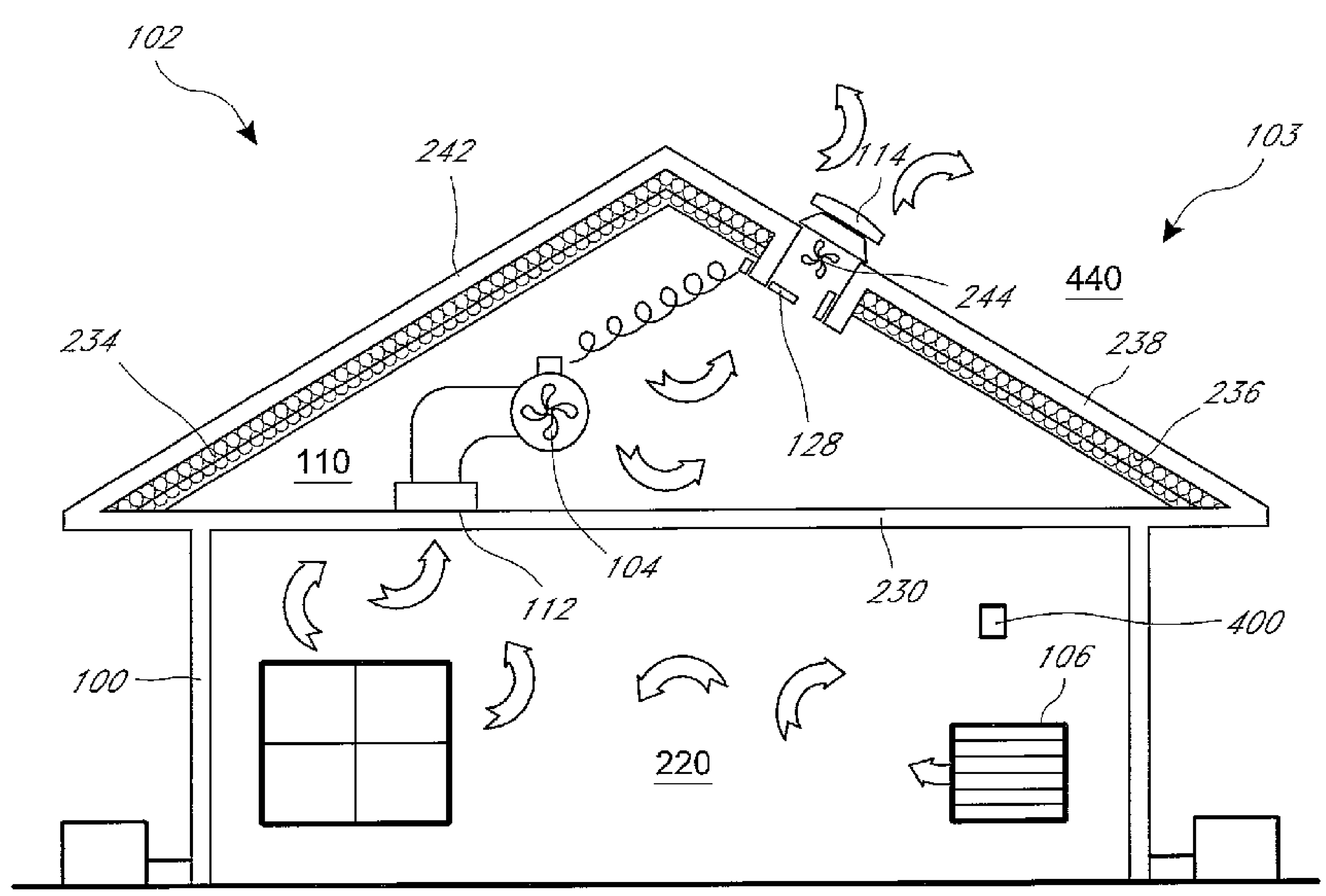
(57) **ABSTRACT**

A fresh-air cooling system for a building structure having an unvented attic is provided. The system provides airflow pathways that allow outside air to be drawn through, and discharged from, a building having an unvented attic. Dampers with a low thermal conductivity regulate airflow through the building structure. The system allows a whole house fan to cool a building having an unvented attic. The system seals or otherwise alters airflow pathways through the building structure in order to reduce heat transfer between the building and the outside environment when the cooling system is not in use.

**21 Claims, 14 Drawing Sheets**



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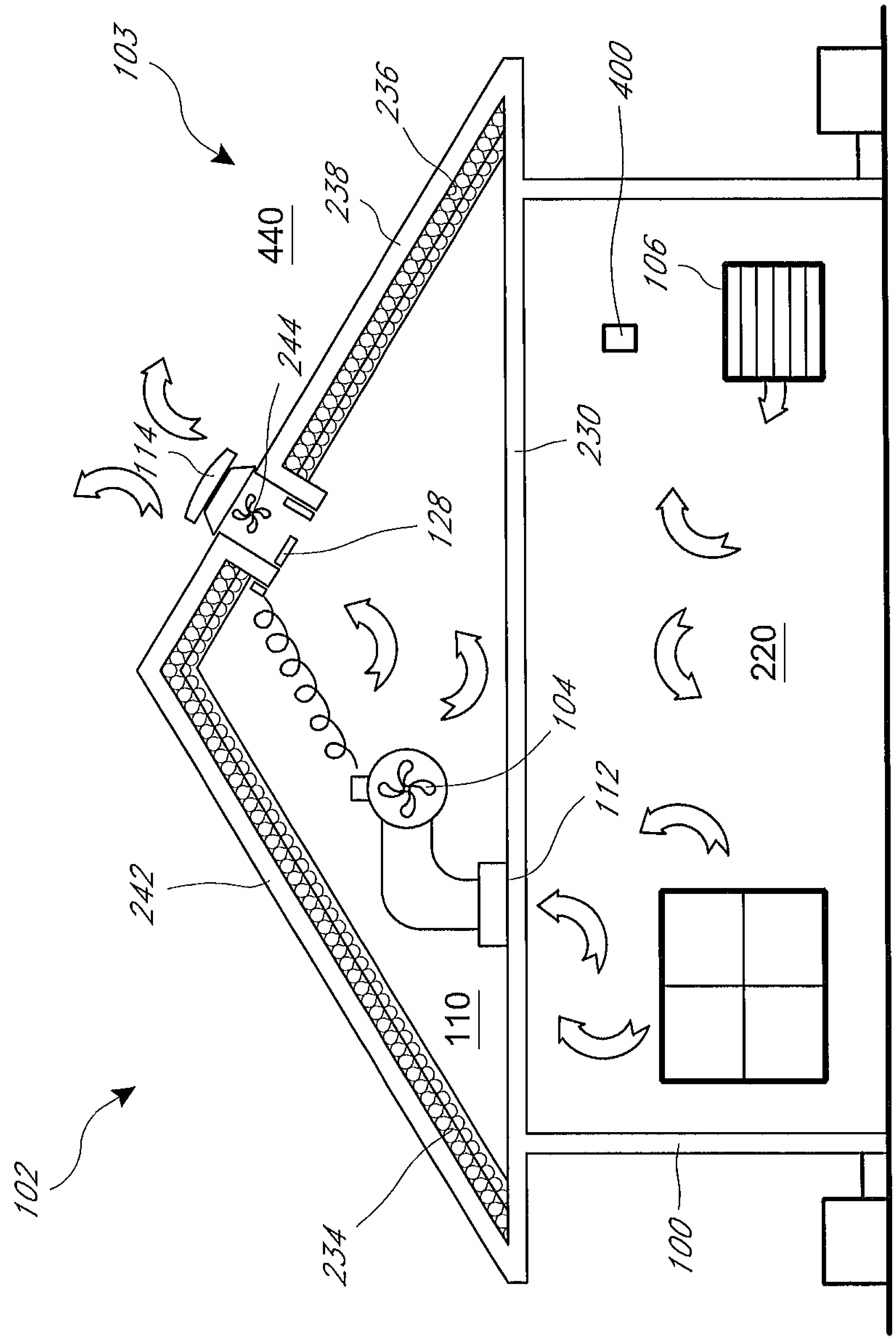
103
236
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440
244
106
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128
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104
112
242
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102
234
100

FIG. 1

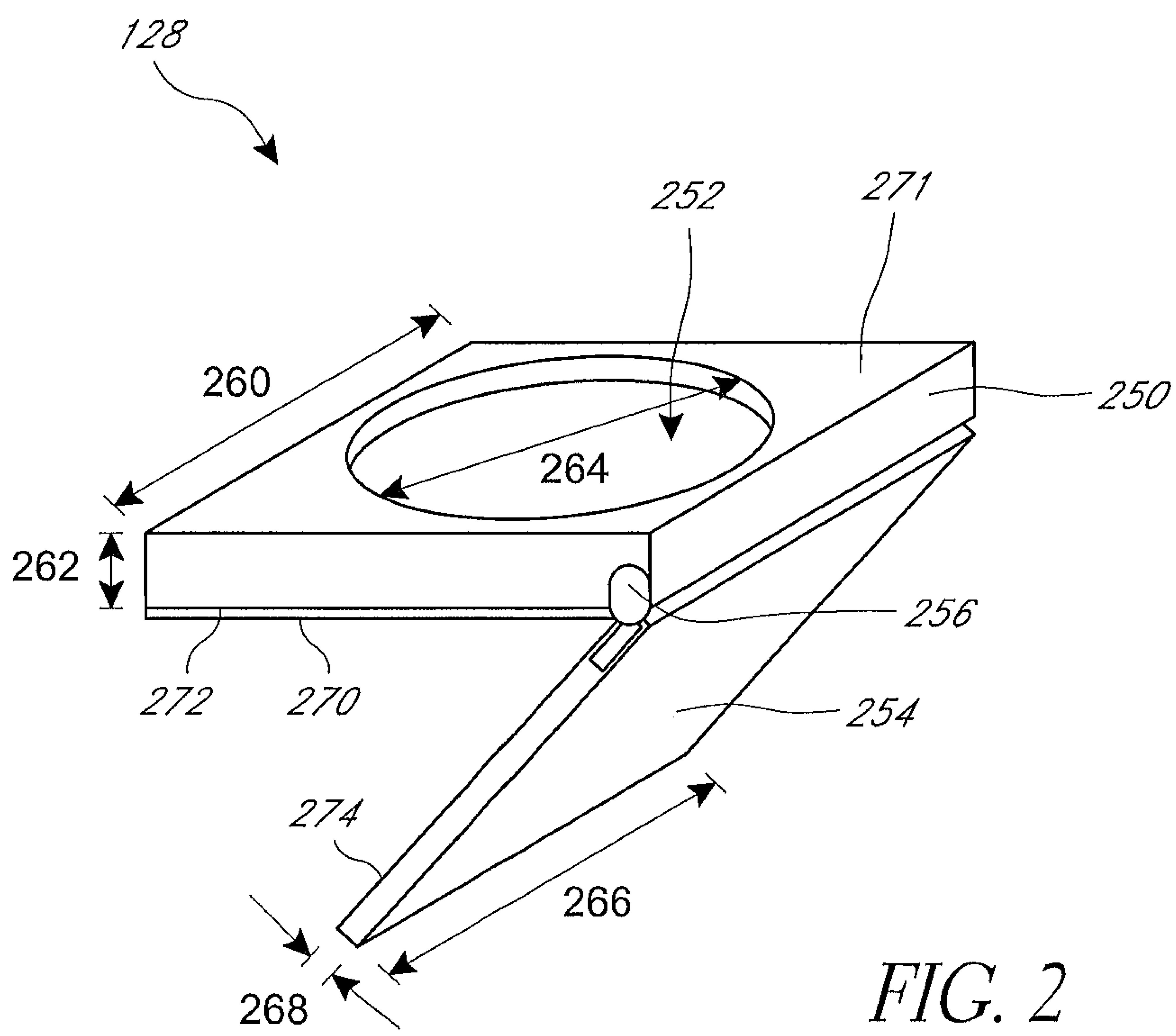
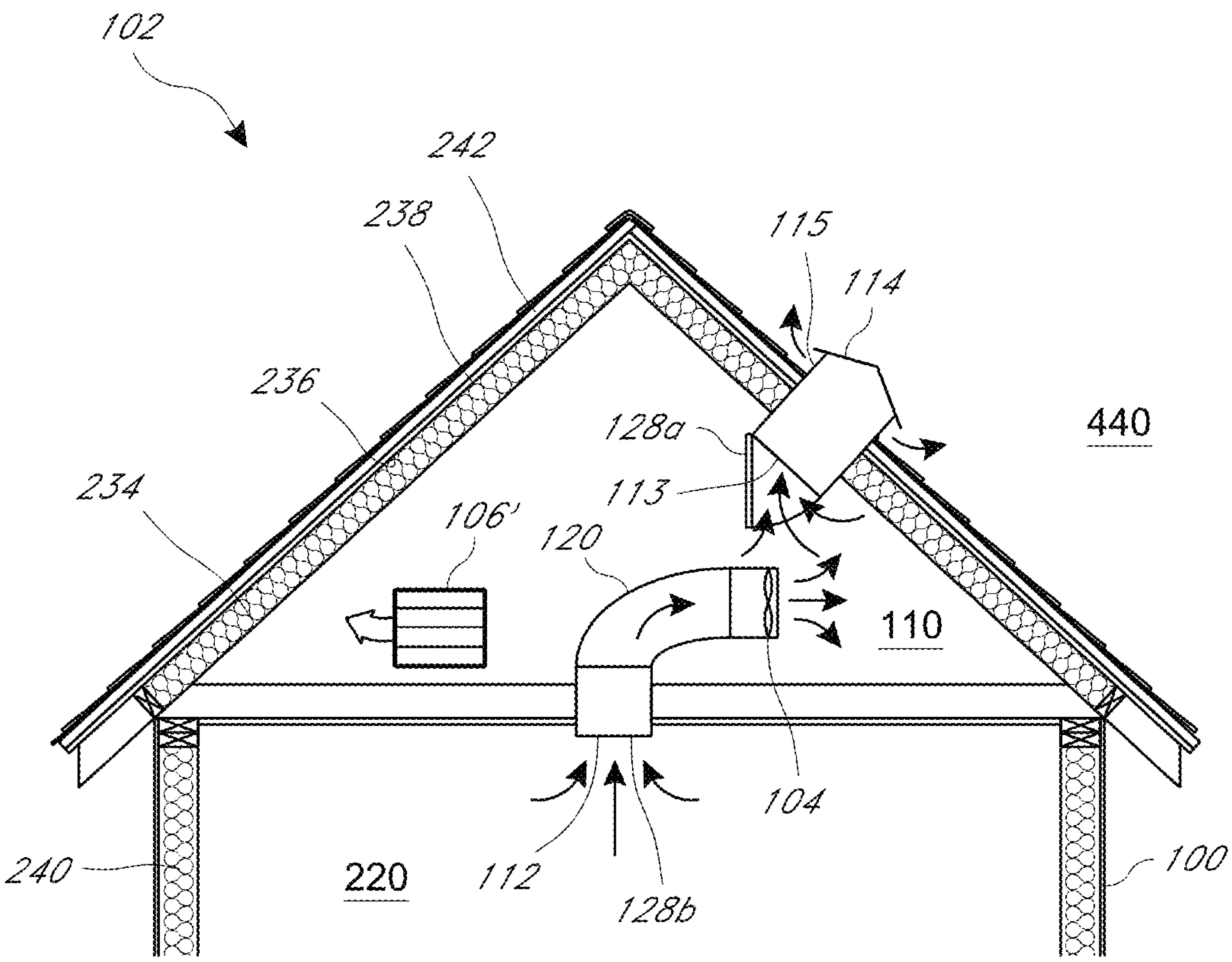



FIG. 2


102
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236
440
128a
234
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220
112
128b

FIG. 3

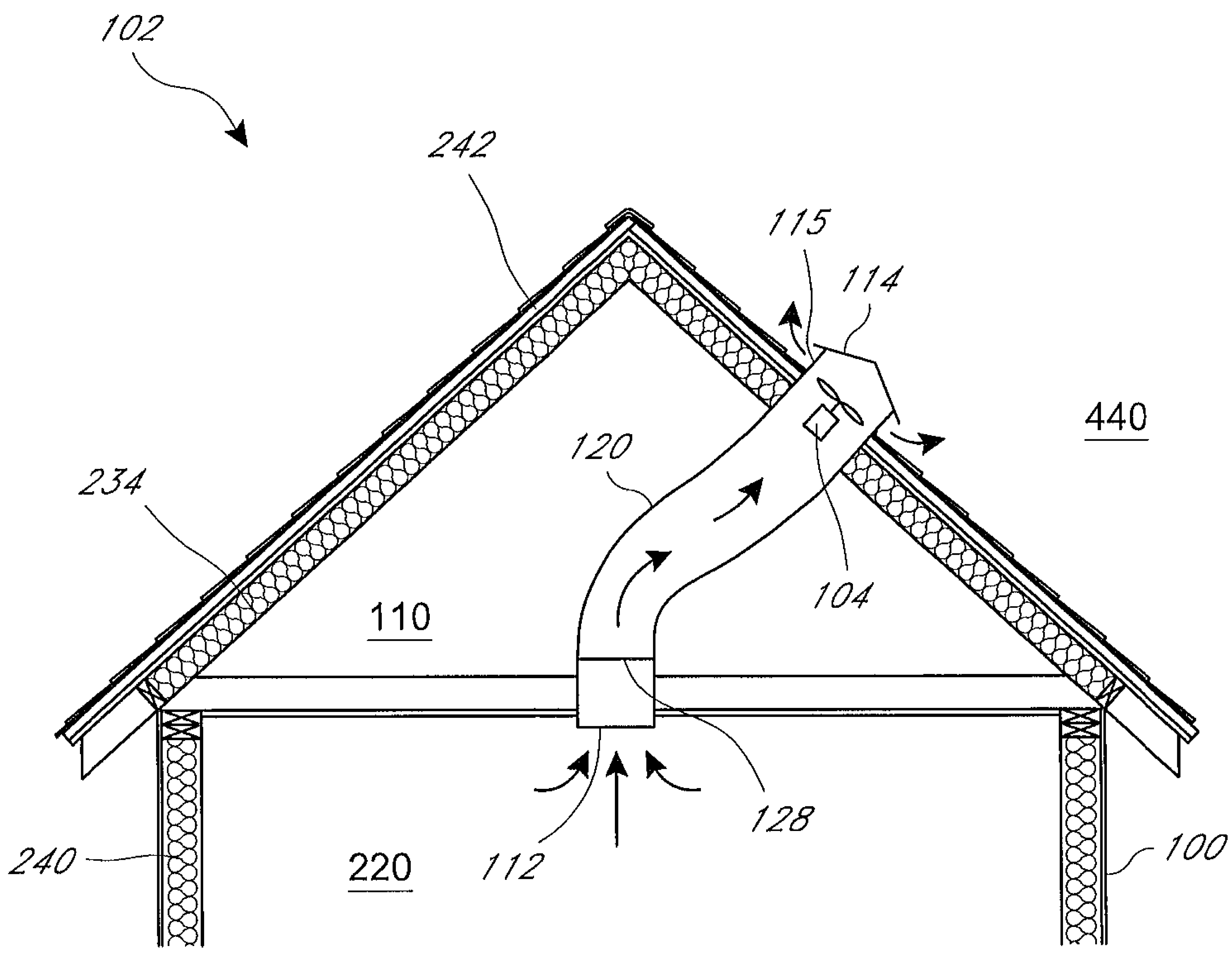



FIG. 4

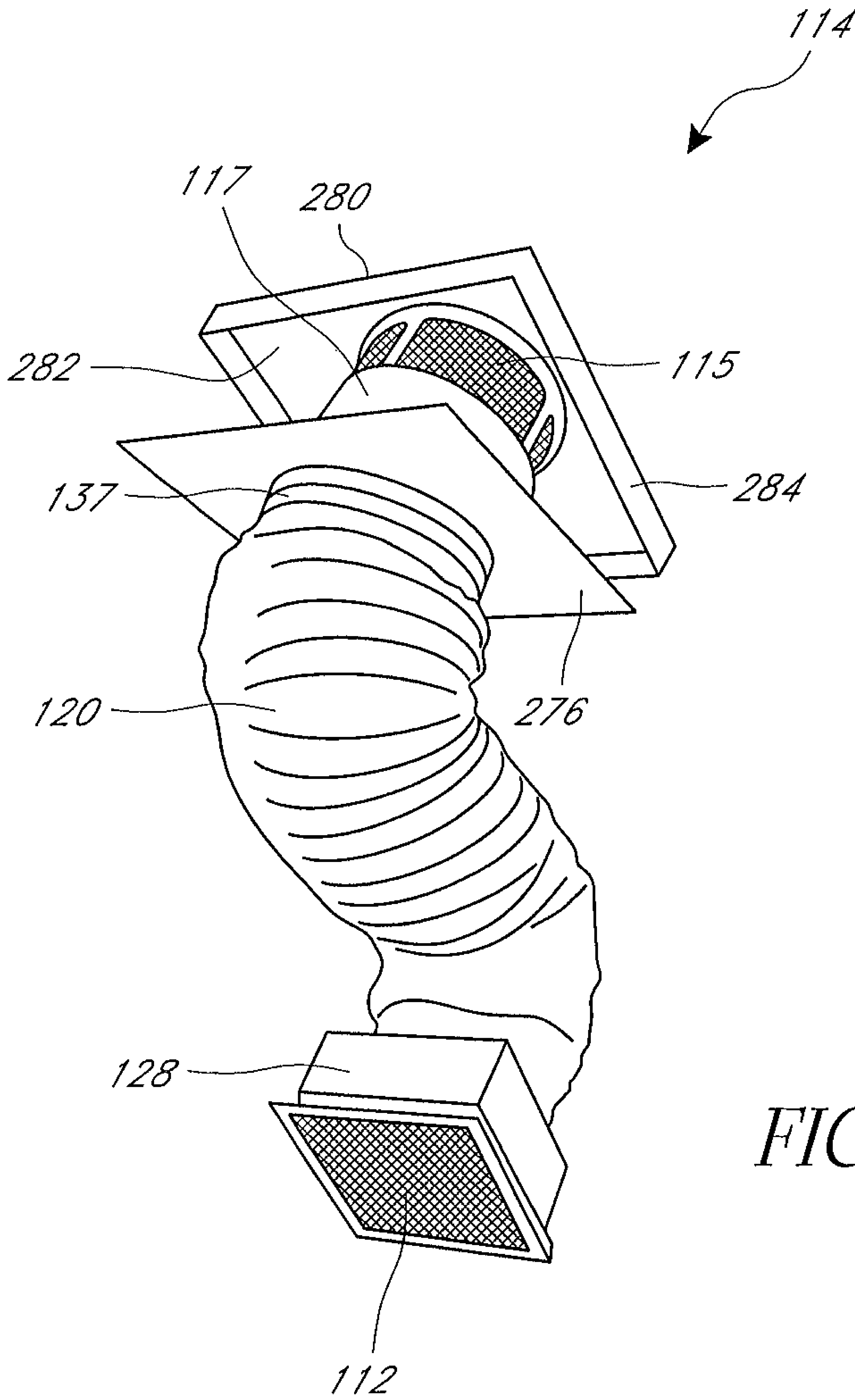



FIG. 5

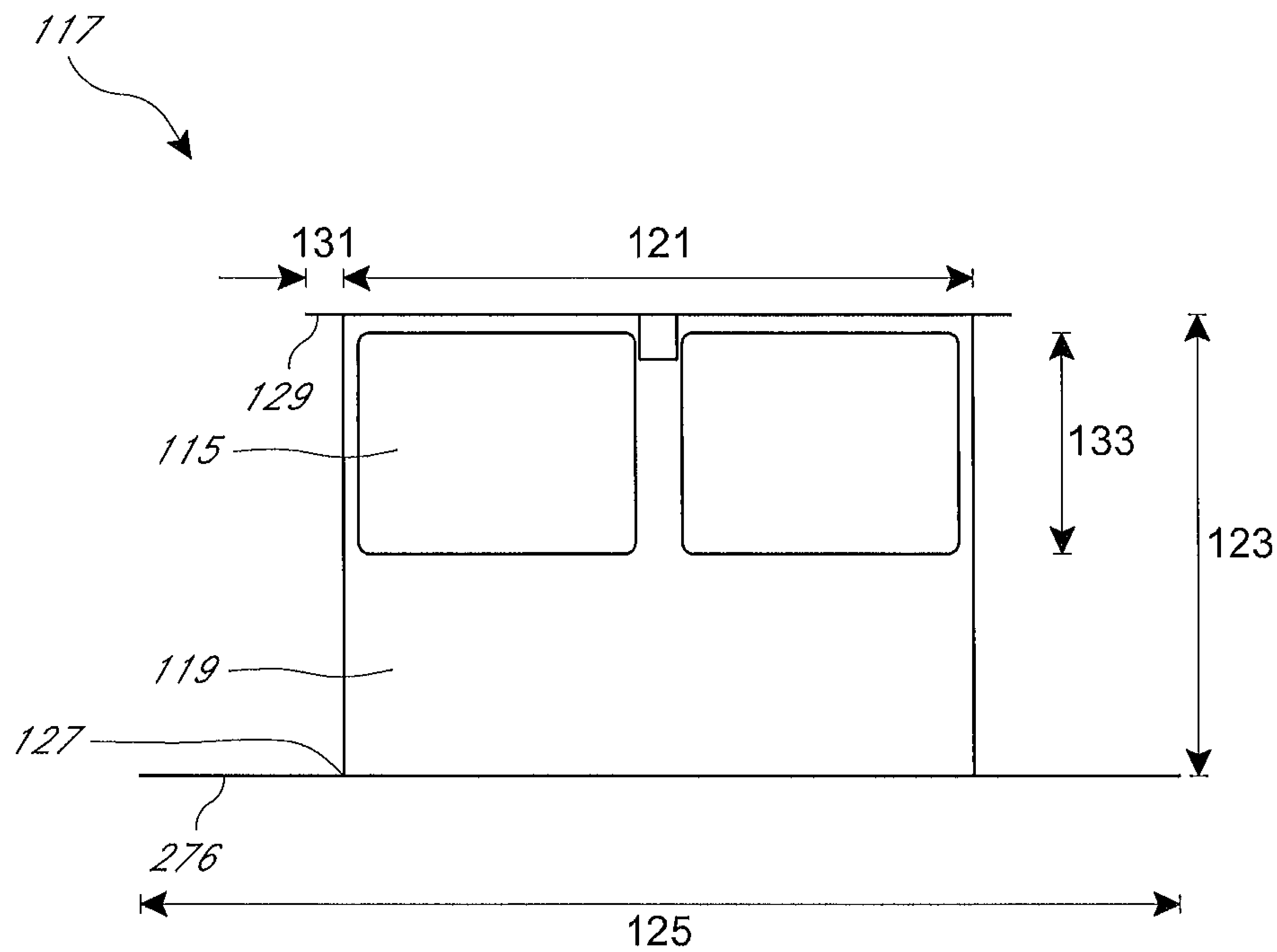



FIG. 6

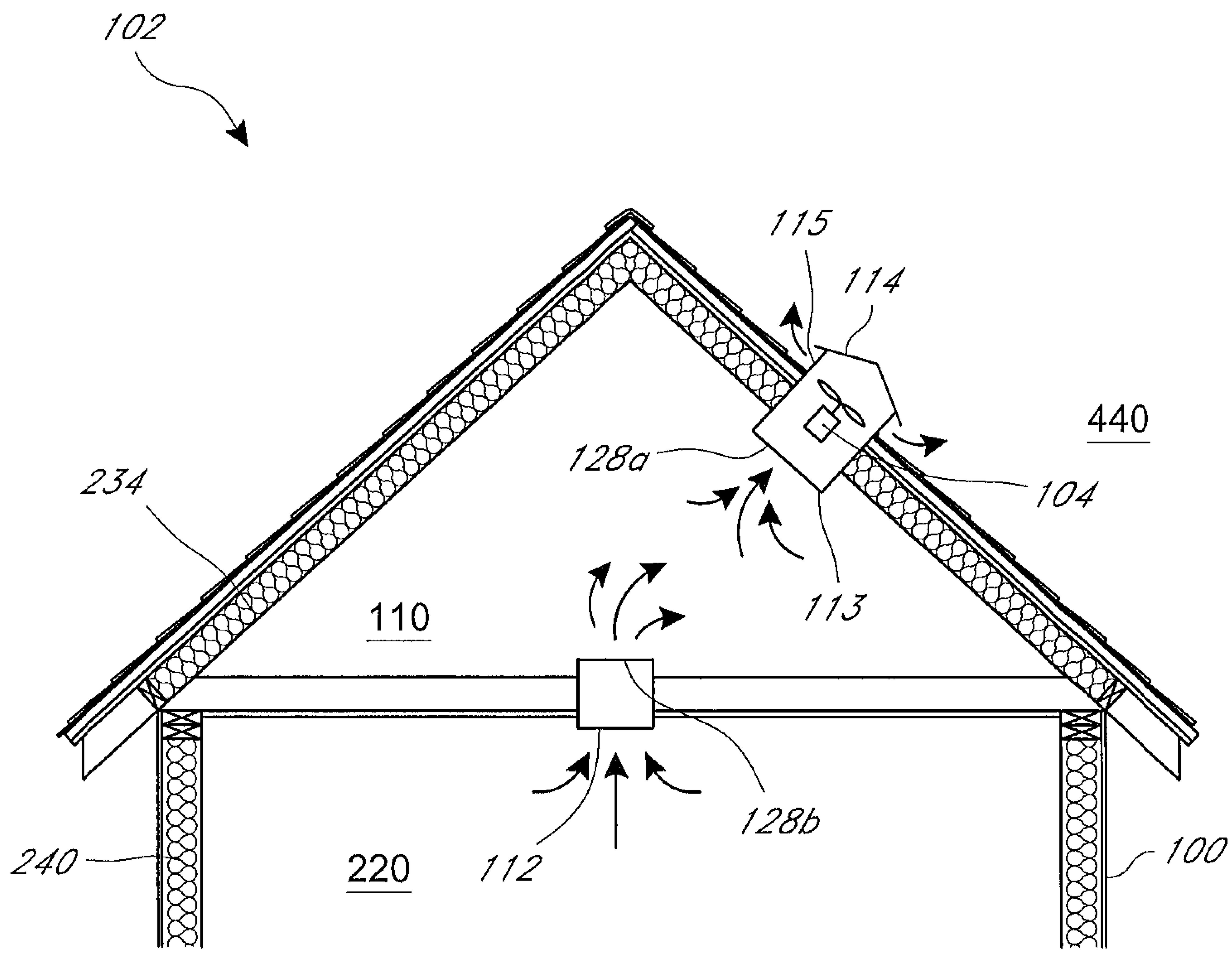



FIG. 7

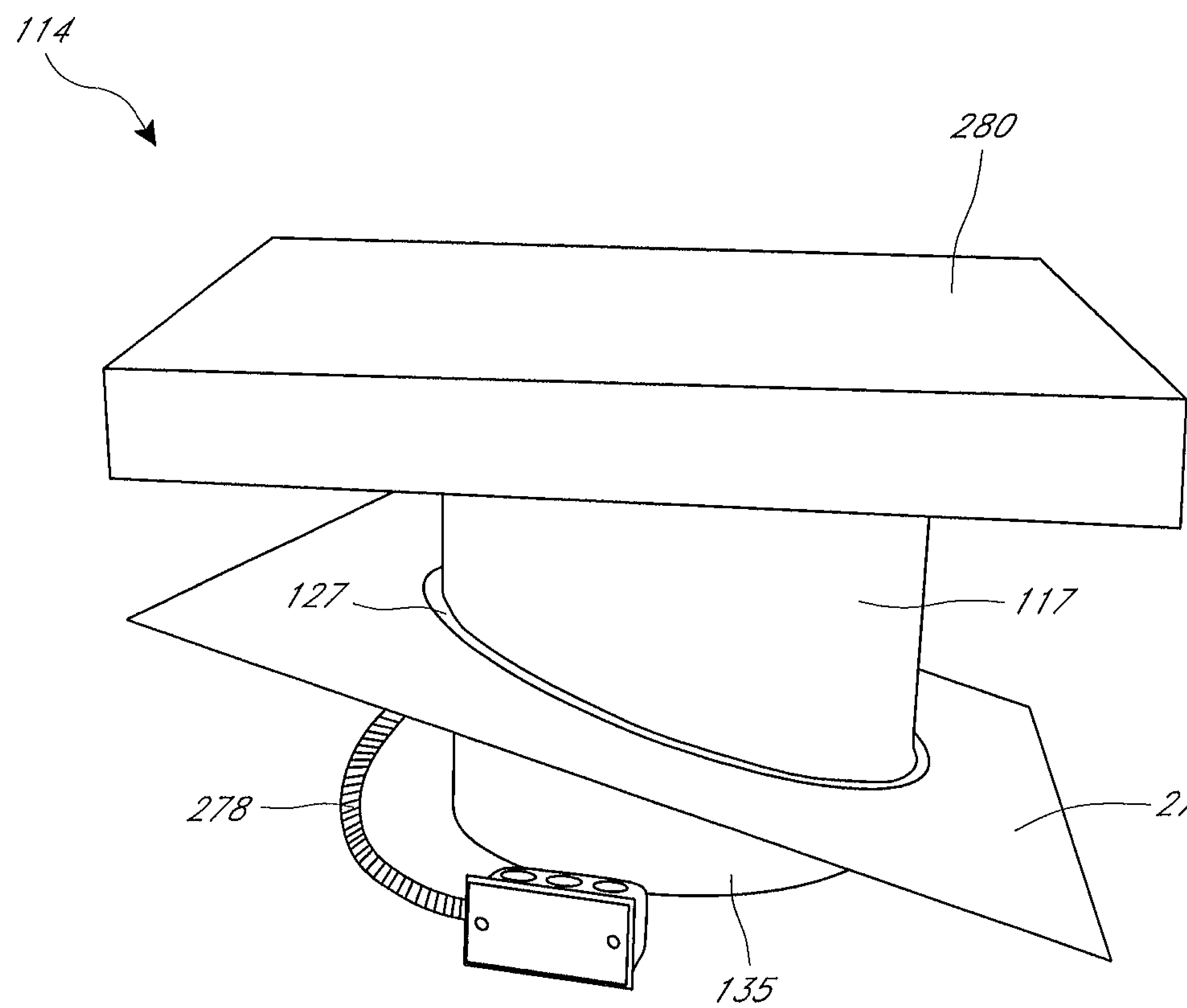



FIG. 8

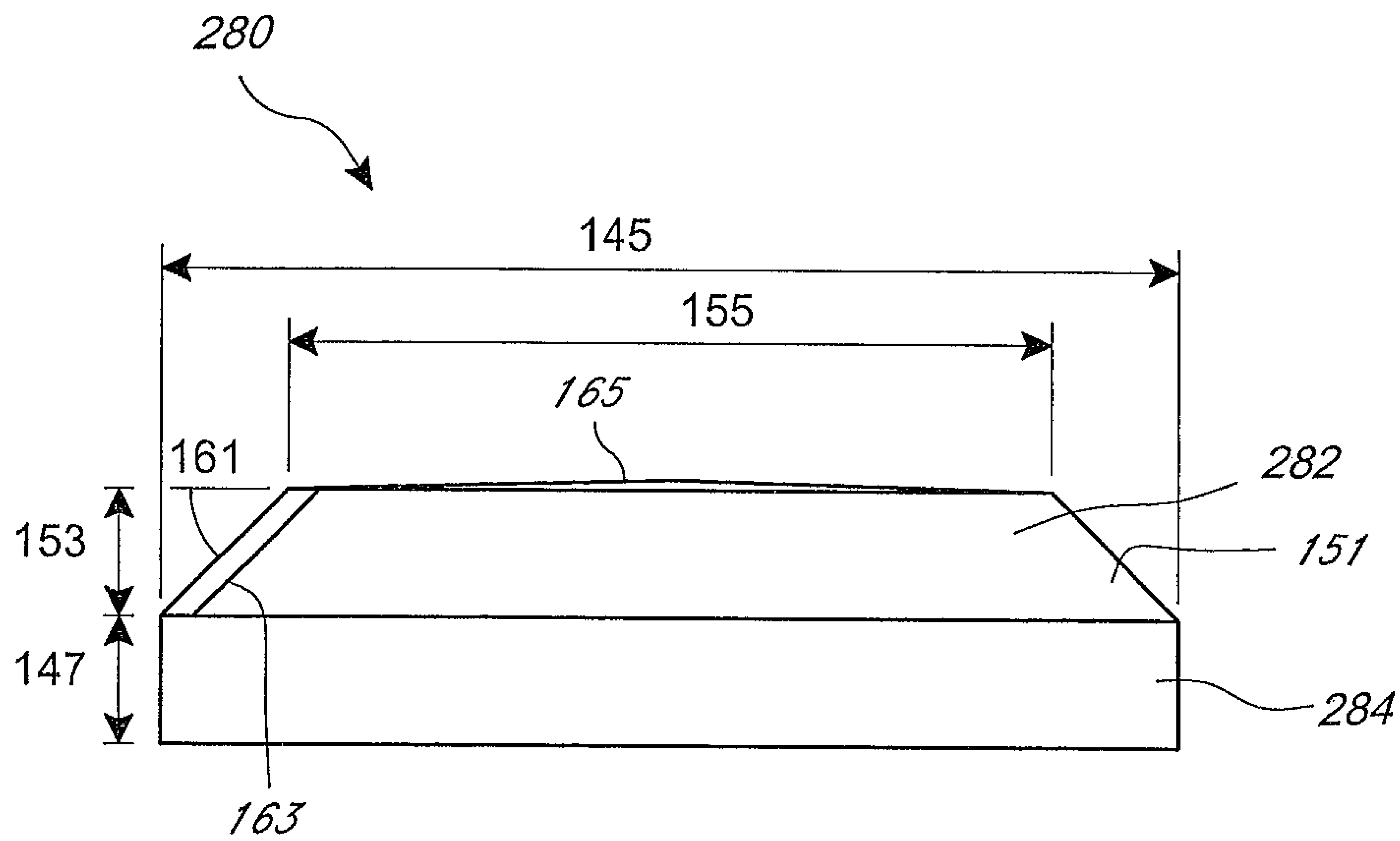



FIG. 9

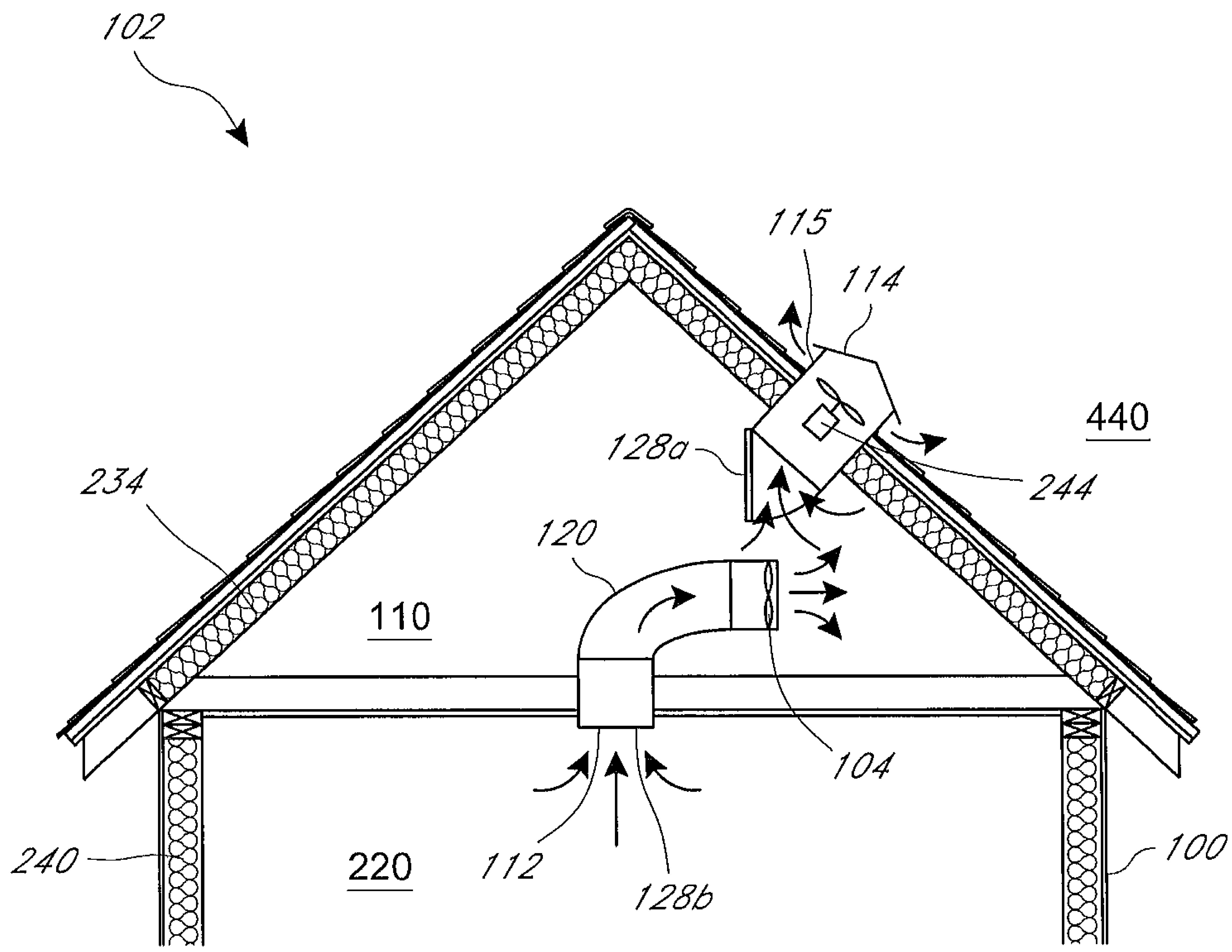



FIG. 10

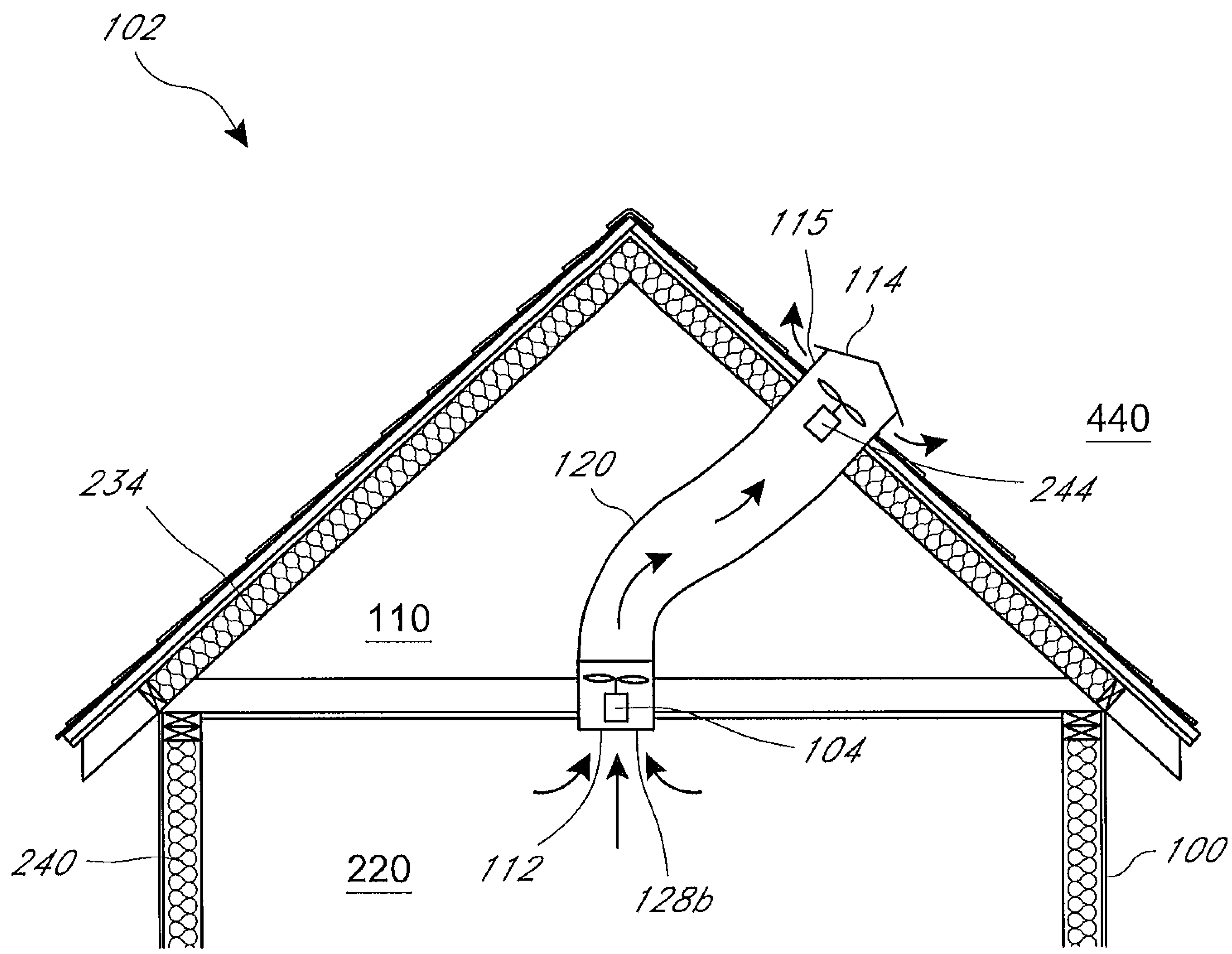



FIG. 11

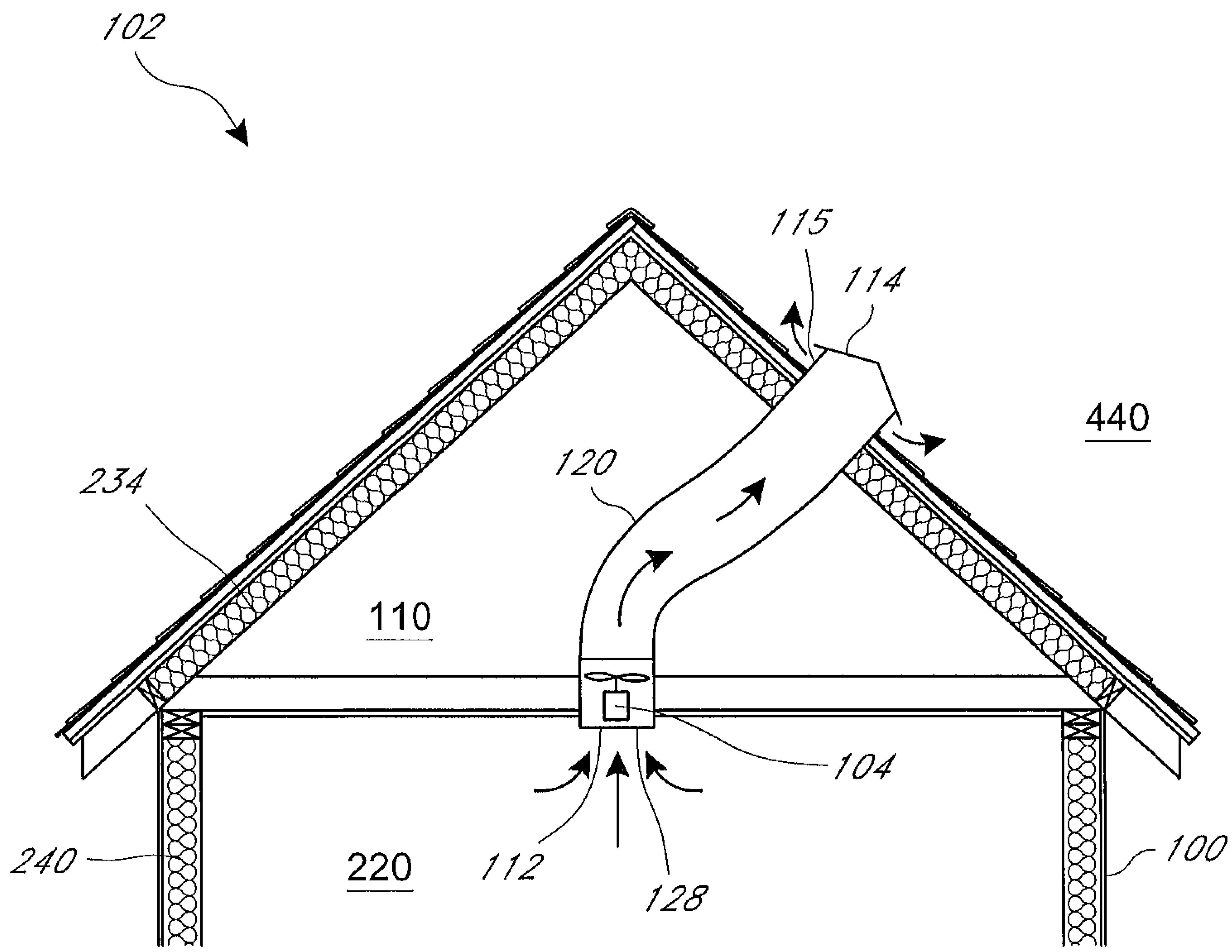
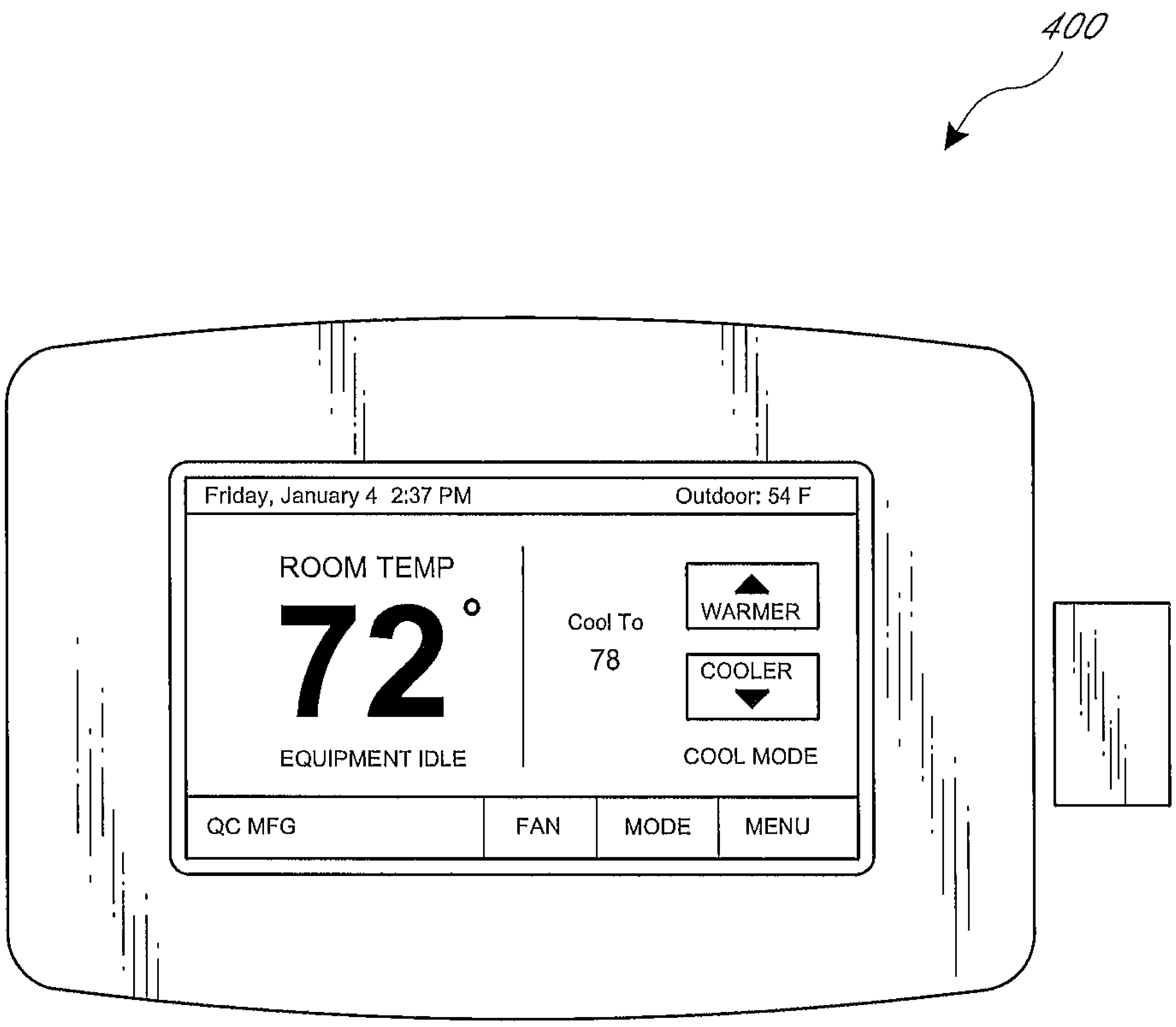



FIG. 12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Outdoor: 54 F
ROOM TEMP
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Cool To
78
WARMER
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FAN
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FIG. 13

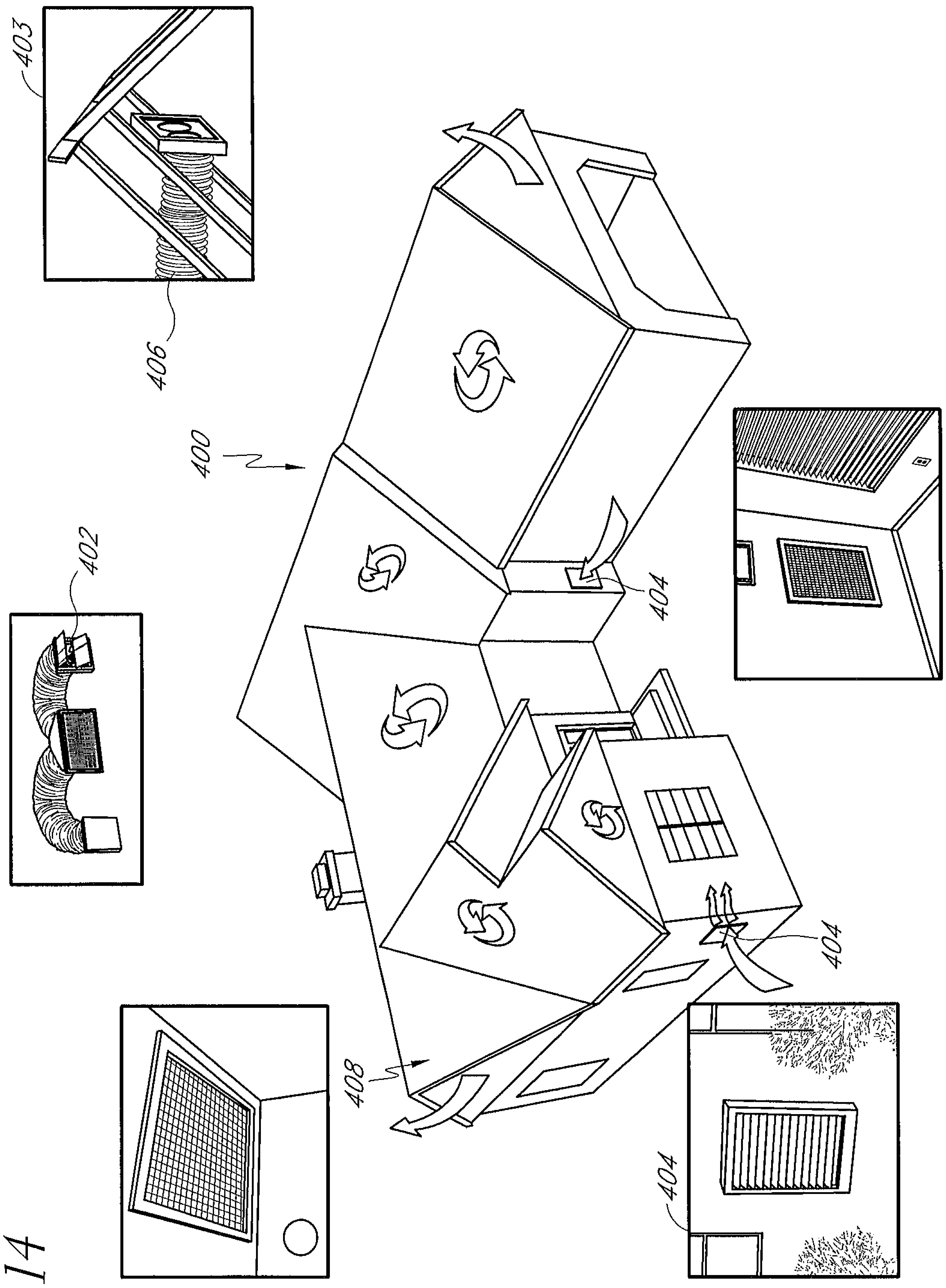


FIG. 14

# AIR COOLING SYSTEM FOR SEALED ATTIC BUILDING STRUCTURES

## INCORPORATION BY REFERENCE TO ANY PRIORITY APPLICATIONS

Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57.

## BACKGROUND

### Field

The disclosure relates generally to cooling systems for building structures, such as those having sealed envelope attics.

### Description of the Related Art

Traditionally, homes have been built with a ventilated attic to help keep the house cooler in the summer and discourage moisture buildup in the attic year-round. In a vented attic, warm attic air rises to the peak of the roof and escapes the attic through a vent near the peak of the roof. The warm air escaping the attic creates a suction force that draws outside air into the attic through other vents (e.g., soffit vents). In this way, attic air is circulated in a vented attic.

In cold climates, attic ventilation helps maintain a cold roof temperature, which avoids ice dams created by melting snow. In hot climates, attic ventilation can help expel solar heated hot air from the attic to lessen the cooling load. Because the air in a vented attic is usually warmer or colder than the air in the living space, vented attics have a layer of insulation between the attic floor and the ceiling of the living space to limit heat transfer from the vented attic to the living space.

Vented attics can be effective, as long as the ceiling deck is well sealed and insulated. But complex roof designs make it difficult to construct a vented roof assembly with an airtight interior barrier at the ceiling plane. Also, it is becoming more common to locate mechanical systems and ductwork in attic spaces. Such ductwork is often leaky or less well insulated, resulting in energy losses and moisture build up in the attic as air flows between the conditioned living space and the vented attic.

More recently, building codes have been modified to allow the construction of unvented or sealed attics (sometimes referred to as high-performance or conditioned attics). In an unvented attic, air-impermeable insulation is applied directly to the underside of the structural roof deck and is tied into the insulation located in the walls so that the roof system becomes part of the insulated building enclosure. Unvented roof assemblies can improve energy efficiency of a home, reduce mold and other contaminants from entering the home, and moderate the temperature differences imposed on ductwork and mechanical systems located within the attic. However, most cooling systems designed for a building structure having an unvented attic rely on air-conditioning systems that use a refrigeration cycle to cool the air. Such systems can be expensive to operate and limit the flow of fresh air into the building. What is needed is a fresh-air cooling system that can be used to regulate temperature in a building having an unvented attic.



## SUMMARY

The systems, methods and devices described herein have innovative aspects, no single one of which is indispensable or solely responsible for their desirable attributes. Without limiting the scope of the claims, some of the advantageous features will now be summarized.

Disclosed herein are embodiments of a temperature regulating system for a building having a sealed attic, otherwise known as an unvented attic, a conditioned attic, or a high-performance attic. The system comprises a fan, an air intake, a vent, a damper, and a flow path for circulating outside air through the building structure. The system allows the flow path to be modified depending on the temperature conditions of the living space, the attic, and/or the outside environment. The system comprises thermally-insulated dampers that seal the vents, and/or the air intakes, and/or the air inlets to limit heat transfer between the attic, the living space, and/or the outside environment.

In some aspects, the system comprises a whole house fan system and at least one insulated mechanical damper, the mechanical damper creating a sealable vent in the unvented attic of the building, wherein the whole house fan and the at least one mechanical damper are electronically and/or electrically connected in order to allow air to flow through the building.

In some embodiments, the system can further comprise a power ventilator. In some embodiments, a power ventilator may not be used. In some embodiments, a plurality of mechanical dampers can be used. In some embodiments, a plurality of power ventilators can be used. In some embodiments, a plurality of whole house fans can be used. In some embodiments, the plurality of mechanical dampers can create a plurality of vents. In some embodiments, some of the vents can incorporate power ventilators whereas other vents do not incorporate power ventilators. In some embodiments, the system can further comprise a thermostat. In some embodiments, the thermostat can control one or more of the vents, the dampers, the whole house fans, the power ventilators, the air intakes, and/or the air inlets. In some configurations, the system can include an air-conditioning system.

In some aspects, the fresh-air cooling system includes a mechanical damper that has an open configuration that allows air to flow through the vent, the air intake, and/or the air inlet. The mechanical damper has a closed configuration that restricts airflow through the vent, the air intake, and/or the air inlet. The mechanical damper has an R-value of between about R4 and R50 when the mechanical damper is in the closed configuration.

In some aspects, the system has an inlet communicating between the unvented attic and the living space of the building. The system has a duct connecting the inlet to a vent that communicates to the outside environment. The duct is configured to prevent air that is in the unvented attic and outside of the duct from entering the vent. In some aspects, the duct has an R-value of between about R4 and R50. In some configurations, a whole house fan is disposed at least partially outside of an unvented attic of the building. In some embodiments, the system has an air intake communicating between the unvented attic and an atmosphere outside of the building. The system has an opening disposed above the air intake, the opening communicating between the attic and the atmosphere outside of the building. In some configurations, the system has an inlet damper configured to control air flow through the air intake. The system has an outlet damper configured to control air flow through the opening. In some embodiments, the system has a first motor that moves the

inlet damper to allow or block air flow through the air intake. The system has a second motor that moves the outlet damper to control air flow through the opening. In some embodiments, a thermostat controls the operation of the first and second motors.

In some aspects, a method of regulating the temperature of a building structure having a sealed attic is provided. The method comprises opening a damper to establish a first flow path between the sealed attic and an atmosphere outside of the building structure, opening an air intake to establish a second flow path between the atmosphere and a space within the building structure, powering a whole house fan to create a static negative pressure in the space within the building structure, and drawing into the space air from the atmosphere, the temperature of the air from the atmosphere being less than the temperature of the space, thereby cooling the building structure.

In some aspects, a vent assembly comprises a whole house fan, a motor housing surrounding the whole house fan, and a flange outwardly extending from the motor housing, an interface between the flange and the motor housing being watertight. In some embodiments, the vent assembly has a tubular duct having a first end attached to a base portion of the motor housing and an air inlet attached to a second end of the tubular duct. In some configurations, the vent assembly has a damper disposed between the air inlet and the motor housing. The damper is movable between an open configuration and a closed configuration. The open configuration of the damper allows air flow between the inlet and the motor housing. The closed configuration restricts air flow between the inlet and the motor housing. In some embodiments, the damper has an R-value of between about R4 and R50 when the damper is in the closed configuration.

## BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through the use of the accompanying drawings.

FIG. **1** illustrates a partial sectional view of a building structure showing an embodiment of a fresh air cooling system;

FIG. **2** depicts an embodiment of a damper;

FIG. **3** is a schematic illustration of an embodiment of the cooling system of the present disclosure;

FIG. **4** is a schematic illustration of an embodiment of the cooling system of the present disclosure;

FIG. **5** depicts an embodiment of an air inlet, duct, and vent assembly of the present disclosure;

FIG. **6** depicts an embodiment of a motor housing;

FIG. **7** is a schematic illustration of an embodiment of the cooling system of the present disclosure;

FIG. **8** is an embodiment of a vent assembly of the present disclosure;

FIG. **9** depicts an embodiment of a removable cover;

FIG. **10** is a schematic illustration of an embodiment of the cooling system of the present disclosure;

FIG. **11** is a schematic illustration of an embodiment of the cooling system of the present disclosure;

FIG. **12** is a schematic illustration of an embodiment of the cooling system of the present disclosure;

FIG. **13** depicts an embodiment of an integrated thermostat;

FIG. **14** is a partial schematic view of a building structure showing an air cooling system of another preferred embodiment of the present disclosure installed therein to cool the building structure.

## DETAILED DESCRIPTION

Embodiments of systems, components and methods of assembly and manufacture will now be described with reference to the accompanying figures, wherein like numerals refer to like or similar elements throughout. Although several embodiments, examples and illustrations are disclosed below, it will be understood by those of ordinary skill in the art that the inventions described herein extends beyond the specifically disclosed embodiments, examples and illustrations, and can include other uses of the inventions and obvious modifications and equivalents thereof. The terminology used in the description presented herein is not intended to be interpreted in any limited or restrictive manner simply because it is being used in conjunction with a detailed description of certain specific embodiments of the inventions. In addition, embodiments of the inventions can comprise several novel features and no single feature is solely responsible for its desirable attributes or is essential to practicing the inventions herein described.

Certain terminology may be used in the following description for the purpose of reference only, and thus are not intended to be limiting. For example, terms such as "above" and "below" refer to directions in the drawings to which reference is made. Terms such as "front," "back," "left," "right," "rear," and "side" describe the orientation and/or location of portions of the components or elements within a consistent but arbitrary frame of reference which is made clear by reference to the text and the associated drawings describing the components or elements under discussion. Moreover, terms such as "first," "second," "third," and so on may be used to describe separate components. Such terminology may include the words specifically mentioned above, derivatives thereof, and words of similar import.

Embodiments of the present disclosure provide for an automated fresh-air cooling system. In some aspects, the present disclosure is directed to a fresh-air cooling that allow a whole house fan to cool a building having an unvented attic. The apparatuses, methods, and cooling systems herein disclosed provide airflow pathways that allow outside air to be drawn through, and discharged from, a building having a sealed or unvented attic. The cooling system of the present disclosure include features that can seal or otherwise alter airflow pathways through the building structure in order to reduce heat transfer between the building and the outside environment when the cooling system is not in use. As described in more detail below, the cooling systems of the present disclosure can be switched between two or more different configurations, thereby allowing airflow and/or heat transfer between the building structure and the outside environment to be regulated.

FIG. **1** discloses a fresh-air cooling system **100** for a building structure **100** with an unvented or sealed attic **110**. Unvented or sealed attic is an attic that is constructed without ventilation and has insulation placed in contact with the roof sheathing instead of the attic floor, and the attic space is air-sealed. Referring to FIG. **1**, in the conditioned or unvented attic **110**, air-impermeable insulation **234** is applied to the underside **236** of the roof deck **238** and is tied to the wall insulation **240** (shown in FIG. **3**) of the building structure **100**. This new insulation position creates a conditioned, unvented attic space, as opposed to the previously used vented attics. Typically, in this new style there are no vents leading outside of the attic through the roof **242**. Accordingly, buildings having an unvented attic **110** often rely on cooling systems that use a refrigeration cycle to cool the air that is enclosed within the building structure **100**.

Fresh-air cooling systems **102** can cool a building structure **100** by drawing cooler outside air through the building structure **100**. As shown in FIG. **1**, a fresh-air cooling system **102** can establish an airflow pathway (shown as thick arrows) that draws outside air into the living space **220** through an air intake **106**. The airflow pathway can push air out of the building structure **100** through a vent **114**. The fresh-air cooling system **102** can include a whole house fan **104** and/or a power ventilator **244** to drive air along the airflow pathway. As discussed in more detail below, the fresh-air cooling system **102** can include an integrated thermostat **400** that can modify or adjust the airflow pathway. In some variants, the integrated thermostat **400** adjusts the airflow pathway based on information received by the integrated thermostat **400**. For example, the integrated thermostat **400** can adjust the airflow pathway based on temperature and/or humidity readings of the living space **220**, the unvented attic **110**, and/or the outside environment **440**.

Whole house fans **104** can be used in the fresh-air cooling system **102** of the present disclosure. Traditional whole house fans discharge into the attic and are therefore useless for cooling a building having a sealed attic **110** because sealed attics **110** provide no pathway for the discharged air to exit the building structure **100**. The fresh-air cooling systems **100** of the present disclosure allow a whole house fan **104** to be used in a building structure **100** having an unvented attic **110**. The cooling systems **102** disclosed herein can include vents **114**, air intakes **106**, air inlets **112**, dampers **128**, whole house fans **104**, and power ventilators **244** that establish and control airflow pathways for circulating air through a building having a sealed attic **110**. Additionally, the fresh-air cooling systems **102** of the present disclosure can include features that reduce heat transfer between the building structure **100** and the outside environment **440**. In some variants, the fresh-air cooling systems **102** disclosed herein include features that reduce heat transfer between the unvented attic **110** and the living space **220**.

With continued reference to FIG. **1**, disclosed herein are whole house temperature control systems that can be incorporated into the new style of sealed, unvented attics. The fresh-air cooling systems **102** of the present disclosure can regulate airflow through the unvented building structure **100**. The cooling system **102** herein disclosed can switch between multiple configurations, allowing the cooling system **102** to regulate airflow and/or heat transfer between the outside environment **440**, the attic **110**, and/or the living space **220**. For example, the cooling systems **102** can have a first configuration that provides an airflow pathway from the living space **220** to the outside environment **440**. The cooling systems **102** can be switched to a second configuration that limits airflow and/or heat transfer between the building structure **100** and the outside environment **440**. In some embodiments, the cooling systems **102** can have a third configuration that limits airflow and/or heat transfer between the attic **110** and the living space **220**. In certain variants, the cooling systems **102** can have a fourth configuration that limits airflow and/or heat transfer between the attic **110** and the outside environment **440**. In some configurations, the cooling system **102** can provide an airflow pathway between the living space **220** to the outside environment **440** while maintaining the unvented attic **110** sealed from the outside environment **440**. In some variants, the cooling system **102** can allow, at least temporarily, airflow between unvented attic **110** and the outside environment **440**.

In some embodiments, mechanical dampers **128** can be used regulate the airflow and/or heat transfer of the fresh air cooling system **102**. The mechanical dampers **128** can be used on one or more components of the fresh-air cooling system **102**. For example, a mechanical damper **128** can control air flow through an air intake **106**, an air inlet **112**, a duct **120**, a vent **114**, and/or an evaporator **404** (discussed below). As discussed below, the mechanical dampers **128** can include features to reduce conductive, convective, and/or radiative heat transfer between the building structure **100** and the outside environment. The mechanical dampers **128** can be opened and closed by a motor and/or controlled by an integrated thermostat **400**.

In some embodiments, the mechanical dampers **128** can have various different shapes such as round, triangular, half round, and the particular shape of the dampers are not limiting. Further, the mechanical dampeners **128** can have a size ranging from approximately half a square foot to 20 square feet, though the size is not limiting. In some embodiments, the mechanical dampeners **128** can have an opening rate of 1 second, 10 seconds, 30 seconds, 1 minute, 5 minutes, 10 minutes, or 20 minutes, and the rate is not limiting. If more than one mechanical dampener **128** is used, the dampeners can have different or the same rates of opening. By having mechanical dampers **128**, and thus providing an exit out of the unvented attic **110**, a whole house fan **104** can be used in the building **100**. The mechanical dampers **128** can be configured to be opened and closed in conjunction with the operation of the whole house fan **104** and/or power ventilator **244**. In some embodiments, the dampers **128** can seal the unvented attic **110** when closed, thus maintaining the unvented space. In some embodiments, a single mechanical damper **128** can be used. In some embodiments, a plurality of mechanical dampers **128** can be used. Different mechanical dampers **128** can be used at different locations on the roof in some embodiments.

In some embodiments, the whole house fan **104** can include fan blades actuated by a motor to expel the internal air out of the building structure **100**. In certain variants, the motor is a variable rpm motor. In some embodiments, the motor can spin at between about 200-4000 revolutions per minute (rpm) and more preferably between about 1500-1600 rpm and about 1550 rpm. In another implementation the motor **116** is between about 1000-1300 rpm and preferably about 1050 rpm. The air flow capacity of the whole house fan **104** can be between about 500-8000 cubic feet per minute (cfm), more preferably between about 2750-4500 cfm, more preferably about 2750 cfm, more preferably about 1500 cfm. In some embodiments, the air flow capacity can be about 2465 cfm. In some embodiments, the air flow capacity can be about 3190 cfm. In some embodiments, the air flow capacity can be about 4712 cfm. In some embodiments, the air flow capacity can be about 2457 cfm. In some embodiments, the air flow capacity can be about 1104 cfm. In some embodiments, the air flow capacity can be about 8000 cfm. In some embodiments, the whole house fan **104** can generate a static negative pressure within the building structure **100**. In some configurations, the whole house fan **104** can generate a static negative pressure within the living space **220** of the building structure **100**.

FIG. 2 depicts a non-limiting, illustrative embodiment of a damper **128**. The damper **128** can be adapted to control air flow through a vent **114**, an air intake **106**, an air inlet **112**, a whole house fan **104**, and/or a power ventilator **244** of a fresh-air cooling system **102**. In some variants, the damper **128** controls air flow through a vent **114** that connects an unvented attic **110** to the outside environment **440**. The damper **128** can have a housing **250** that surrounds an opening **252**. The opening **252** can be sized to receive at least a portion of the vent **114**. In some embodiments, the opening **252** is sized to receive the vent **114** into the opening **252** and to form a substantially air-tight seal with the vent **114**. The damper **128** can include a door **254**. The door **254** can be coupled to the housing **250** by a hinge **256**, thereby allowing the door **254** to move between an open configuration, in which the door **254** uncovers the opening **252**, and a closed configuration, in which the door **254** covers the opening **252**. A motor (not shown) can control the movement of the door **254**, as described above for other embodiments of the damper **128**.

In some variants, the damper **128** has a plurality of hinged shutters or blades that cover the opening **252** instead of the unitary door **254** shown in the illustrated embodiment. In some embodiments, the blades or door **254** can be moved to a closed position by gravity when the fan **104** or power ventilator **244** is not operating, thereby covering the opening **252**. When the fan **104** or power ventilator **244** is operating, air flow generated by the fan **104** and/or ventilator **244** can force the blades or door **254** to open, thereby allowing air to flow through the opening **252**. In some variants the blades or door **254** can be opened and closed by mechanical means (e.g., a motor). In a preferred embodiment, the blades or door **254** are made of an insulating material so that when they are closed, they substantially prevent air from passing through the opening **252** and/or prevent heat conduction through the damper **128**. The insulating R value through the damper can be R4 to R50 with closed dampers and more preferably about 4.2, more preferably about 5 and more preferably about 6.8.

The damper **128** can be designed to reduce conductive, convective, and/or radiative heat transfer between the unvented attic **110** and the living space **220**, between the unvented attic **110** and the outside environment **440**, and/or between the living space **220** and the outside environment **440**. The blades or door **254** of the damper **128** can include a material having a low thermal conductivity (e.g., glass, wool, cork, polystyrene foam, vacuum insulated panel). In some variants, the blades or door **254** can have an evacuated core or other features known in the art to minimize heat conduction through the blade or door **254**. The damper **128** can include a coating that reflects incident radiation, and/or minimizes absorbed radiation, and/or reduces transmitted radiation. In some embodiments, the damper **128** can be configured to have an R-value of between about R4 and about R50 when the damper **128** is in the closed configuration.

In the illustrated embodiment, the housing **250** is square, has a side length **260** of about 27 inches, a thickness **262** of about 2 inches, and a circular opening **252** with a diameter **264** of about 22 inches. The illustrated embodiment has a door **254** that is square with a side length **266** of about 24 inches and a thickness **268** of about 1 inch. However, the damper **128** can have other configurations. For example, the housing **250**, opening **252**, and/or door **254** can be bigger, smaller, thicker, or thinner than the illustrated embodiment. Additionally, the housing **250** and/or door **254** need not be square, and the opening **252** need not be circular. The housing **250** and the door **254** can be made of the same material or can be made of different materials. In some embodiments, the housing **250** is made of sheet metal, while the door **254** is made of a material having a low thermal conductivity. In some embodiments, the housing **250** can include or be made from a material having a low thermal conductivity.

The damper **128** can have a top surface **271** that attaches to the roof sheathing of the building structure **100**. In some variants, the damper **128** can include a rubber seal **270** that helps create a substantially airtight seal between the door **254** and the housing **250** when the door **254** is in the closed position. The seal **270** can be disposed on a bottom face **272** of the housing **254**. In some embodiments, the seal **270** can be disposed on a top face **274** of the door **254**. In some variants, the damper **128** can include a seal **270** on both the top face **274** of the door **254** and the bottom face of the housing **254**. The seal **270** can be made of rubber or other suitable materials (e.g., thermal insulating foam).

In some embodiments, the damper **128** can be partially closed to reduce the rate and/or pathway of air flow in the home. The damper **128** can include a mechanical or electrical switch sensor to indicate position of the damper door **254**. The switch sensor can communicate with the integrated thermostat **400** to provide fine tuning of the airflow rate to adjust the atmospheric comfort levels within the building. Further, the switch sensor can provide for a visual or auditory cue to a user to communicate the position of the damper blades door **254**. In some embodiments, the cooling system **102** can modify position of the damper **128** in order to alter airflow rate and/or pathway in order to reduce heat transfer between the building structure **100** and the outside environment.

Referring to FIG. **3**, the fresh-air cooling system **102** can include a vent **114** that provides a pathway for air to exit the unvented attic **110** through the roof **242** of the building structure **100**. When the whole house fan **104** is operating, the cooling system **102** of the illustrated embodiment establishes an airflow pathway from the living space **220**, to the unvented attic **110**, and then to the outside environment **440**. In this way, the fresh-air cooling system **102** establishes an airflow pathway through which outside air is pulled into the living space **220**. The living space air is drawn into the unvented attic **110**. The attic air mixes with air that is pulled from the living space **220** and discharged into the unvented attic **110**. The air is then discharged from the unvented attic **110** to the outside environment **440** through the vent **114**. This configuration of the cooling system **102** can help cool the unvented attic **110** and reduce heat conduction to the living space **220** from the floor of the unvented attic **110** and the ceiling of the living space **220**. This configuration of the cooling system **102** also reduces convective heat transfer to the living space **220** and/or the unvented attic **110** because airflow is in the direction from the living space **220** to the attic **110** and then to the outside environment **440**. When the living space **220** reaches a desired temperature, the fresh-air cooling system **102** can deactivate the fan **104** and/or power ventilator **244** and close the dampers **128** to reduce heat transfer from the living space **220** and/or from the attic **110**.

Because the attic air in an unvented attic **110** is susceptible to solar heating, the fresh-air cooling system **102** can include features that reduce attic heating and the subsequent potential heat transfer from the attic **110** to the living space **220**. For example, the fresh-air cooling system **102** can include a vent **114** near the apex of the roof **242** that communicates between the unvented attic **110** and the outside environment. The fresh-air cooling system **102** can include an air intake

**106'** near the attic floor that communicates between the unvented attic **110** and the outside environment **440**. The fresh-air cooling system **102** can open the vent **114** and the air intake **106'**, at least temporarily, to effectively convert the unvented attic **110** into a vented attic, thereby reducing the temperature of the air in the attic.

In some embodiments, the fresh-air cooling system **102** can tailor the airflow pathway through the building **100** depending on the temperature and/or humidity conditions in the building **100** and outside environment **440**. For example, if the fresh-air cooling system **102** detects that the living space **220** is at a comfortable temperature but that the unvented attic is warm, the fresh-air cooling system can be configured to open the first damper **128***a*, at least partially, to allow hot attic air **110** to escape the building structure **100**, while maintaining the second damper **128***b* closed. In this way, the fresh-air cooling system **102** may establish an airflow pathway between the unvented attic **110** and the outside environment **440**, while restricting airflow between the unvented attic **110** and the living space **220**. This modification of the airflow pathway can allow the fresh-air cooling system **102** to reduce heat conduction from the unvented attic **110** and the living space **220**.

In some embodiments, the cooling system **102** can include an air intake **106'** that is positioned near the floor of the attic **110** and communicates between the attic **110** and the outside environment **440**. The fresh-air cooling system **102** can open the air intake **106'** near the attic floor and open the first damper **128***a* while maintaining the second damper **128***b* closed, thereby effectively converting the unvented attic **110** into a vented attic. The air intake **106'** near the attic floor can include a thermally insulated damper **128**, as described above. In some embodiments, the cooling system **102** can include a logic circuit that determines whether to open the first damper **128***a* based on the temperature of the attic, the living space, and/or the outside environment **440**.

FIG. **4** shows another embodiment of the fresh-air cooling system **102** for use in a building structure **100** having a sealed or conditioned attic **110**. In the illustrated embodiment, a duct **120** connects an air intake **112** to a whole house fan **104** that is disposed within a vent **114** that has an outlet **115** outside of the roof **242**. In some variants, a power ventilator **244** can be installed within the vent **114** in place of the whole house fan **104**. In the illustrated embodiment, the damper **128** is disposed between the air inlet **112** and the duct **120**. This positioning of the damper **128** can prevent warm air in the attic **110** from transferring heat to the living area **220** when the whole house fan **104** is off. For example, convective heat transfer from the attic **110** to the living space **220** can be reduced by sealing the damper **128** so that air does not flow from the attic **110** into the living space **220**. Conductive heat transfer through the damper **128** can be reduced by making the damper **128** from a material with a low thermal conductivity. Additionally, the duct **120** can be insulated to reduce the warm air in the unvented attic **110** from warming the air within the duct **120**. Because conductive heat transfer is driven by temperature gradients, reducing the temperature of the air within the duct **120** will reduce the conductive heat transfer across the damper **128**.

In some embodiments, the whole house fan **104** is positioned partially or completely outward of the air-impermeable insulation **234** that is applied to the roof sheathing of the building structure **100**. In some variants, the whole house fan **104** is positioned completely within the attic **110**. For example, the whole house fan **104** can be disposed within a portion of the vent **114** that extends inward of the air-impermeable insulation **234**. As discussed, the damper **128** can be configured to open when the whole house fan **104** is turned on. When the damper **128** is open, the cooling system **102** can provide an airflow pathway for the whole house fan **104** to draw air from the living space **220** and discharge air directly to the outside environment **440**. The whole house fan **104** pulls air from the living space **220** through the air inlet **112**, through the damper **128**, through the duct **120**, and through the whole house fan **104**. The whole house fan **104** then pushes the air through the outlet **115** of the vent **114**. When the whole house fan **104** is off, the damper **128** can move to the closed position, thereby preventing outside air from moving into the building structure.

With continued reference to FIG. **4**, the damper **128** can be disposed in locations other than between the air inlet **112** and the duct **120**. In certain variants, the damper **128** can be disposed partially or completely within the duct **120**. In some configurations, the damper **128** is disposed within the vent **114** upstream of the whole house fan **104**. In some variants, the cooling system **102** includes a plurality of dampers **128** disposed in one or more of the aforementioned locations.

FIG. **5** shows a non-limiting embodiment of a vent **114** assembly for the fresh-air cooling system **102** depicted in FIG. **4**. The duct **120** connects the air intake **112** to the vent **114**. The damper **128** is disposed between the duct **120** and the air intake **112**. In the shown embodiment, the vent **114** is coupled to a flange **276** that helps seat the vent **114** on the roof of the building structure **100**, as described below. Although not visible in FIG. **5**, the whole house fan **104** is located within a motor housing **117**, which is adjacent to the flange **276** in the illustrated embodiment.

As shown in FIG. **5**, the vent **114** can include a cap **280**. The cap **280** can be configured to allow air to exit the vent **114** while preventing rain or debris from entering the vent **114**. For example, the cap **280** can have a tented portion **282** that extends radially beyond the outlet **115** of the vent **114**. The cap **280** can include a lip **284** that extends from the tented portion **282** toward the flange **276**. In this way, the tented portion **282** and the lip **284** can form an umbrella-like structure that prevents water from flowing into the outlet **115** of the vent **114**. The outlet **115** can be covered by a screen or grill that prevents debris, insects, or animals from entering the vent **114** through the outlet **115**.

As shown, the cap **280** can be angled relative to the flange **276**. In some embodiments, the cap **280** is angled relative to the flange **276** so that when the flange **276** is flush with a sloped roof, the cap **280** is inclined at a steeper angle than the roof. In other words, the gap between the cap **280** and the roof increases in the direction of the apex of the roof. The angle of the cap **280** can be selected so that the cap **280** obscures the vent **114** when viewed from the street level. The top surface of the cap **280** can be coated with a material that reflects incident radiative heat. As described in more detail below, the cap **280** can be fitted with a removable cover that matches the roof of the building structure, making the cap **280** less noticeable. In some embodiments, the cap **280** is configured to provide a lower resistance to the airflow through the outlet **115**. For example, the angle between the lip **284** and the tented portion **282** can be increased for the portion of the lip **284** that is closest to the apex of the roof, thereby lowering the airflow back pressure on the outlet **115** while maintaining protection of the vent from debris and water.

FIG. **6** shows a non-limiting, illustrative embodiment of the motor housing **117** portion of the vent **114**. In some embodiments, the motor housing **117** surrounds a whole house fan **104**. In certain variants, the motor housing **117** surrounds a power ventilator **244** (e.g., attic fan). The motor housing **117** can have a body portion **119** that has one or more outlets **115** through which air can exit the motor housing **117** to reach the outside environment. In the illustrated embodiment, the body portion **119** is circular and has a diameter **121** of about 14½" and a height **123** of about 10½". One end of the body portion **119** can be attached to a flange **276**. In the illustrated embodiment, the flange **276** is square and has a side length **125** of about 24 inches. The interface between the flange **276** and the body portion **119** can comprise a watertight seal **127**. As mentioned above, the flange **276** can help secure the body portion **119** to the roof of the building structure **100**. The watertight seal **127** can prevent water from penetrating the roof of the building structure **100**. The end of the body portion **119** that is opposite of the flange **276** can include a rim **129**, as shown in FIG. **18**. The rim **129** extends a distance **131** radially beyond the body portion **119** of the motor housing **117**. In the illustrated embodiment, the distance **131** is about ½". As mentioned above, the body portion **119** can include one or more outlets **115**. In the illustrated embodiment, the outlets **115** have a longitudinal dimension **133** of about 5 inches and extend about ¼ of the circumference of the body portion **119**. The outlets **115** can be covered by a screen mesh. In some variants, the outlets **115** are covered by a ¼" screen mesh.

FIG. **7** shows another embodiment of the fresh-air cooling system **102** configured for use in a building structure **100** having an unvented attic **110**. In the illustrated embodiment, the vent **114** is not connected to the air inlet **112** by a duct **120**. This allows the air in the unvented attic **110** to join the airflow pathway that the fresh-air cooling system **102** establishes from the living structure **220** to the outside environment **440**. As discussed above, drawing air from the unvented attic **110** can reduce solar heating of the attic air and heat conduction to the living space **220** the floor of the attic and the ceiling of the living space **220**. The illustrated embodiment has a first damper **128*a*** configured to seal the vent **114** when the whole house fan **104** is not in use, thereby preventing warm outside air from entering the unvented attic **110** and/or cool attic air from escaping the building structure **100**. The fresh-air cooling system **102** has a second damper **128*b*** configured to seal the air inlet **112**, thereby preventing warm attic air from entering the living space and/or cool air from the living space **220** from entering the unvented attic **110**.

In the illustrated embodiment, a first damper **128*a*** controls airflow through the vent **114**. The vent **114** has an inlet **113** that is positioned within the attic **110** and an outlet **115** that is disposed outside of the roof **242**. The first damper **128*a*** can move between an open configuration, in which air can flow through the vent **114**, and a closed configuration, in which air flow through the vent **114** is restricted. In some variants, the fresh-air cooling system **102** can include a second damper **128*b*** that controls air flow through the air inlet **112**. The vent **114** and/or the air inlet **112** can have a cross-sectional area of between about 1 sqft. to about 16 sqft.

FIG. **8** shows a non-limiting, illustrative embodiment of the vent **114** that can be used in the cooling system depicted in FIG. **7**. The vent **114** has a motor housing **117**, a flange **276**, and a cap **280**, as described above. The vent **114** can include an electrical conduit **278** for providing electrical current to power the whole house fan **104** or power ventilator **244** that is housed inside the motor housing **117**. The base portion **135** of the motor housing **117** can be configured to couple to a damper **128** (not shown). For example, the base portion **135** can be sized to fit into the opening **252** (shown in FIG. **2**) of a damper **128**. In some embodiments, the base portion **135** can be sized to fit inside of the duct **120**, as shown in FIG. **5**. With continued reference to FIG. **5**, the duct **120** can be sealed to the base portion **135** by a collar **137** that prevents air from passing between the inner surface of the duct **120** and the outer surface of the base portion **135**. The collar **137** can be an adhesive tape, a tightening band collar, or other suitable means known in the art.

FIG. **9** depicts an embodiment of a removable cover **280** that can be attached to the top portion of the vent **114**. In the illustrated embodiment, the cover **280** tapers in the direction away from the roof of the building structure **100**. In the shown embodiment, the base portion **284** of the cover **280** is square and has a side length **145** of about 24 inches and a height **147** of about 3 inches. The cover **280** can have other shapes and/or dimensions. In the illustrative embodiment, the top portion **282** of the cover **280** is square and has side panels **151** that are trapezoidal. The side panels **151** have a height **153** that is about 3 inches. The side panels **282** have a top length **155** that is about 18 inches. The side panels **282** can slope toward the base portion **284** at an angle **161**, as shown in FIG. **9**. In the illustrated embodiments, the angle **282** is about 45°. The side panels **149** can be attached to one another along a seam **163**. The seam **163** can be watertight. The cover **280** can have a top surface **165**. In some embodiments the central portion of the top surface **165** is tented relative to the radially outward portions of the top surface **165**, forming a crown. In the illustrated embodiment, the crown has a height of about ¼".

FIG. **10** shows another embodiment of the fresh-air cooling system **102** for use in a building structure **100** having an unvented attic **110**. In the illustrated embodiment, the cooling system **102** has a power ventilator **244** within a vent **114** that has a damper **128*a***. The damper **128*a*** controls access of the air in the attic **110** to the vent **114**. When the cooling system **102** is running, the damper **128*a*** opens to allow the power ventilator **244** to help pull air out of the attic **110** and discharge the attic air to the outside atmosphere. The illustrated cooling system **102** also includes a whole house fan **104** that discharges into the attic **110**. The whole house fan **104** is coupled to an inlet **112** by a duct **120**, as described above. The cooling system **102** includes a second damper **128*b*** that controls air flow from the living space **220** through the air inlet **112**. In the illustrated embodiment, the second damper **128*b*** is located near the ceiling of the living space **220**. In some variants, the second damper **128*b*** can be located near the inlet of the duct **120** or near the outlet of the duct **120**. Additionally, the power ventilator **244** can be replaced with a whole house fan **104**. As discussed above, the illustrated embodiment can include one or more features (e.g., an air intake **106** near the attic floor) that allow the fresh-air cooling system **102** to convert the unvented attic into a vented attic, at least temporarily, when the whole house fan **104** is not in use.

FIG. **11** shows another embodiment of the fresh-air cooling system **102** for use in a building structure **100** having an unvented attic **110**. In the illustrated embodiment, the cooling system **102** has a whole house fan **104** that is positioned at or near the floor of the attic **110**. The cooling system **102** has a damper **128** that controls air flow through the air inlet **112** to the whole house fan **104**. The whole house fan **104** discharges into an insulated duct **120** that communicates with a vent **114** having an outlet **115** disposed outside of the building structure **100**. The vent **114** houses a power ventilator **244** that can help draw the air out of the building structure **100**. In some variants, the power ventilator **244** in the vent **114** can be replaced with a whole house fan **104**.

Additionally, the cooling system **102** can include a second damper **128**_b_ (not shown) that is interposed between the vent **114** and the duct **120**, thereby preventing outside air from entering the duct **120** when the cooling system **102** is not on. As discussed in regard to the embodiment of FIG. **10**, the illustrated embodiment can include one or more features (e.g., an air intake **106** near the attic floor, a vent **114** near the apex of the roof **242**) that allow the cooling system **102** to convert the unvented attic **110** into a vented attic, at least temporarily, when the whole house fan **104** is not in use.

FIG. **12** shows another embodiment of the fresh-air cooling system **102** for use in a building structure **100** having an unvented attic **110**. In the illustrated embodiment, the cooling system **102** has a whole house fan **104** positioned at or near the floor of the attic **110**. A damper **128** near the air inlet **112** controls the flow of air from the living space to the inlet of the whole house fan **104**. The whole house fan **104** discharges into an insulated duct **120** that is connected to a vent **114** having an outlet **115** positioned above the roofline of the building **100**. As discussed in regard to the embodiment of FIG. **11**, the illustrated embodiment can include one or more features (e.g., an air intake **106** near the attic floor, a vent **114** near the apex of the roof **242**) that allow the cooling system **102** to convert the unvented attic into a vented attic when the whole house fan **104** is not in use.

When the whole house fan **104** is off, the cooling system **102** can be configured to close the first damper **128**_a_, thereby reducing airflow and convective heat transfer from the outside environment **440** to the attic **110**. The first damper **128**_a_ can be thermally insulated, as discussed above, to reduce heat transfer by conduction from the roof **242** and/or the outside environment **440** to the attic **110** through the damper **128**_a_. In some embodiments, the first damper **128**_a_ can be configured to have an R-value that is equal to or greater than the R-value of the air-impermeable insulation **234** when the first damper **128**_a_ is in the closed position.

In some embodiments, the fresh-air cooling system **102** can include more than one vent **114**. In certain variants, the fresh-air cooling system **102** includes a plurality of vents **114**, with each vent **114** having its own damper **128**. In some configurations, the cooling system **102** can have a plurality of vents **114** that communicate with a common channel (not shown). The common channel can be interposed between the plurality of vents **114** and the attic **110**. The common channel can have a damper **128** that controls air flow between the attic **110** and the plurality of vents **114**. One or more of the plurality of vents **114** can include a damper **128** that controls flow between the common channel and an individual vent **114** of the plurality. As mentioned above, the operation of the dampers **128** can be controlled and/or coordinated by an integrated thermostat **400**.

FIG. **13** depicts an embodiment of an integrated thermostat **400**. The thermostat **400** can be an electronic control switch that controls the cooling and ventilation and humidity systems in a building. The integrated thermostat **400** can be in communication with an air intake **106** system, a whole house fan **104** system, and if present, an air conditioning system to fully optimize air control throughout the building structure **100**, while reducing the overall energy output of the building structure **100**. In some embodiments, the integrated thermostat **400** can be in communication with the motors of the air intake **106** system to activate the dampers **128**. Also, as described above, the motors and/or dampers **128** can include position information sent to the integrated thermostat **400**. As described in detail below, the integrated thermostat **400** can open and close the air intake **106**, turn on and off the whole house fan **104** system, open and close the external air vent **114**, and turn on and off the air conditioning system without any user input. Therefore, the entire cooling and ventilation system can be completely automated.

The use of the mechanical dampers **128** described above can create a controlled mechanical attic ventilation (CMAV), or airflow system **103**. In some embodiments, the whole house fan **104** and the CMAV **103** can be wired directly together. In some embodiments, the whole house fan **104** and the CMAV **103** can be in communication with one another wirelessly. In some embodiments, the whole house fan **104** and the CMAV **103** can be in communication indirectly with one another through a different system. In some embodiments, the vents **114** can be electrically and/or electronically opened. In some embodiments, a controller can be used to open and close the mechanical dampers **128**. In some embodiments, the mechanical dampers **128** can be in communication with the whole house fan **104** to open and close. In some embodiments, the mechanical dampers **128** can provide for an airtight seal when closed. The mechanical dampers **128** can be controlled in tandem with the whole house fan **104**, and thus can be synced with the whole house fan **104** in some embodiments.

FIG. **14** provides a partial sectional view of a building structure **400** showing a fresh-air air cooling system of one preferred embodiment of the present disclosure installed therein to cool the building structure having an unvented attic **110**. In the embodiment shown in FIG. **14**, the building structure **400** is a one-story residential house. In operation, a negative pressure or vacuum created by the fan assembly **402** (e.g., whole house fan **104**, and/or power ventilator **244**) draws outside air in through the evaporator systems **404** located adjacent various rooms inside the house, such as the living room and the bedroom. The evaporator system **404** cools the air by evaporation as it passes through the wetted media and into the living area. The air is drawn through the ceiling mounted ducts **406** and into the fan and expelled into the attic **408**. The positive pressure created in the attic forces air to exit the attic through venting vent system and substantially inhibit outside air from entering the attic through the vent system, e.g. intake or exhaust. In some embodiments, a thermostat or switch can be used to turn on or off the fan assembly to maintain a constant temperature in the home. In one implementation, the thermostat is adapted to turn evaporator system pump on when the temperature inside the building structure has reached a preset level, and to turn the evaporator system pump off when the temperature inside the building structure has dropped back down below a preset level. In one implementation, the thermostat is electronically wired to turn on the evaporator system pump when the temperature inside the living area reaches about 75 degrees F. and to turn off the pump when the temperature inside the living area drops down to about 72 degrees F.

As also shown in FIG. **14**, the air cooling system can be positioned to regulate cooling of individual rooms of the house. The system can include a control mounted on the wall of each room of the house. The control can be a wall mounted toggle or timer switch and the like. The fan systems for each individual room can be turned on or off, thereby providing the capability of controlling the cooling of individual rooms. In some embodiments, the system utilizes a single large fan, having an airflow capacity of between about 2750 cfm to 8000 cfm. In other embodiments, the system can include a plurality of smaller fans, each having an air flow capacity of about 1500 cfm. In operation, when the system **200** is turned off for a particular room, the gravity operated damper closes off the duct to substantially prevent air in the attic from entering the living area and substantially reduce the transfer of heat or cold into the living area through radiation.

The air cooling system of certain preferred embodiments is capable of reducing the outside temperature by about 40° F. Unlike conventional air conditioners which recirculate air inside a building structure, the air cooling system of preferred embodiments is capable of exchanging the indoor air with clear fresh air, preferably 3 to 4 times per minute for a 2000 square foot house, while also cooling the air inside. Unlike conventional swamp coolers which tend to introduce excessive moisture into the dwelling, the air cooling system of the preferred embodiments is capable of cooling the interior of a building structure while leaving the interior air at a humidity level of about 45%-60%. Further, the novel design of the air cooling system is configured to create a positive pressure environment inside the attic, which forces the warm air to be expelled from the attic through all open vents in the attic. In preferred embodiments, the air cooling system is capable of reducing the attic temperature by as much as 50° F. Additionally, during operation, the system operates more quietly than prior art systems with equivalent cooling effectiveness. In certain preferred embodiments, during operation, the sound level generated by the system in the living area is between about 0.4 to 0.6 sones.

Advantageously, the air cooling system utilizes an energy efficient evaporator similar to swamp coolers or evaporative coolers, however the evaporative system is configured in a small attractive protrusion on the exterior of the house wherein the typical evaporative cooler is large, un-attractive box shaped appliance attached to the exterior. Another advantage is that the multi-fan system allows individual rooms to be cooled or not cooled depending on which fan is turned on or off. Another advantage is that the cooling system provides effective cooling inside both the living area as well as the attic area of a building structure. Another advantage is that the cooling system is capable of exchanging the air inside a building structure with fresh air while maintaining effective cooling. Another advantage is that the cooling system operates more quietly than other evaporative cooling systems with equivalent cooling effectiveness.

In some embodiments, a power attic ventilator **244** can be used in order to move air out of the building structure **100**. The power attic ventilator **244** could be, for example, a fan mounted cylinder that could mount to the dampers **128**. The ventilator **244** can then be used to blow or suck air out of the building **100**, thereby improving temperature change rates in the building **100**. In some embodiments, the ventilator **244** can be an attic fan. In some embodiments, the flow rate of the ventilators **244** can be approximately the same as the flow rate of the whole house fan **104**. In some embodiments, the ventilators **244** can be located outside or inside the roof line.

In some embodiments, a power attic ventilator **244** may not be used. If a ventilator **244** is not used, a larger attic exit point (and thus larger or more mechanical dampers **128**) would likely be used in order to properly regulate temperature in the building **100**. In some embodiments, the use of the ventilators **244** can allow for more square footage of the roof to be covered with solar panels.

There are many advantages to using a whole house fan **104** with a roofline insulated building rather than an attic floorline insulated building. For example, a building can experience significant energy savings as an unvented attic can be warmer in the winter and cooler in the summer. This can reduce overall HVAC load. Further, by insulating the whole of the attic **110**, the equipment can last longer as it is less likely to experience environmental hazards.

Further, by insulating the attic **110**, the buildings moisture resistance can be improved. The attic **110** can stay drier than floorline insulation attics, and thus can reduce or avoid problems with mold and wood rot.

Moreover, roofs having unvented attics are less likely to be blown off by high winds, such as tornadoes, as wind has less access to the inside of the attic. Further, as there are no vents into the attic, fire hazards from floating embers are generally diminished. In addition, in coastal climates, the unvented attics can keep out salt spray and rain, thus reducing corrosions and other damages.

In some embodiments, the fresh air cooling system **102** of the present disclosure can be used in conjunction with an air conditioning system. The integrated thermostat **400** can automatically determine optimal utilization of the air conditioning system by preferring the fresh air cooling system **102** over the air conditioning system. When the external temperature is at or below the internal temperature and the integrated thermostat **400** calls for cooling, the thermostat **400** can activate the fresh air cooling system **102** and can turn off the air conditioner. When the external temperature is above the internal temperature and the thermostat calls for cooling, the integrated thermostat **400** can automatically deactivate the fresh air cooling system **102** and can turn on the air conditioner. In some embodiments, the integrated thermostat **400** can include error correction features such that the air conditioning system cannot be turned on when the thermostat detects that the fresh air cooling system **102** is active. Conversely, in some embodiments, the fresh air cooling system **102** will not activate when the thermostat detects that the air conditioning system is activated. In some embodiments, the integrated thermostat **400** also will not allow the whole house fans **104** to activate unless the air intakes **106**, vents **114**, and dampers **128** are in their open positions.

The automated fresh air cooling system **102** can have the flexibility to be installed in several different HVAC building environments to provide an energy savings and cost savings. For example, embodiments of the disclosed automated fresh air cooling system **102** can be installed in a building **100** without an air conditioning system, retrofitted to be installed in a building **100** with an existing air conditioning system, or installed as part of an air conditioning system installation.

Embodiments of the disclosed automated fresh-air cooling system **102** may require only a fraction of the energy of the air conditioning system and therefore can result in a significant energy and cost savings compared to traditional air conditioning systems by reducing the demand of the air condition system. Further, a user is not required to open the air intake, and the thermostat can seamlessly switch between the fresh air cooling system and an air conditioning system when present.

As discussed above, the fresh-air cooling systems **102** can include an integrated thermostat **400**. In some embodiments, the integrated thermostat **400** can be coupled with one or more temperature and/or humidity sensors to make fine-tuned control decisions. Temperature and/or humidity sensors can be placed both inside the building structure and outside in the ambient environment to determine optimal conditions for activating the whole house fan system.

In some embodiments, the integrated thermostat **400** can include a touch-screen interface for programming the device. In some embodiments, the integrated thermostat **400** can also be used to control other secondary automated building functions such as security, lighting, and major appliances. In some embodiments, the integrated thermostat **400** can be used to control heating in a manner similar to the air conditioning system. In some embodiments, the integrated thermostat **400** can be activated remotely via a cellular telephone or by personal computer. In some embodiments, a user can determine the existing indoor temperature, outdoor temperature and humidity, and presently active units from a remote location through remote communication with the integrated thermostat. A user can also use the remote function to make program or control changes in the cooling and ventilation system. In some embodiments, the integrated thermostat **400** can be coupled with energy load sensors to provide an energy management report and energy efficiency recording of the building. In some embodiments, the energy load sensors can be placed on major appliances, the fresh air cooling system, and the air conditioning system to provide instantaneous energy reports.

As should be appreciated by one skilled in the art, the fresh air cooling system has the flexibility to be installed in several different HVAC building environments to provide an energy savings and cost savings. In some embodiments, the fresh air cooling system **102** can be installed in a building without an existing air conditioning system. In such an installation, the integrated thermostat **400** can make control decisions on whether to activate the fresh air cooling system based on the external and internal building temperature and/or humidity conditions. In some embodiments, the fresh air cooling system **102** can be retrofitted to a building with an existing air conditioning system. In such an installation, the integrated thermostat **400** can use the internal and external temperature and/or humidity sensors to make control decisions about whether to activate either the fresh air cooling system or the existing air conditioning. As described in detail with respect to the control algorithm, the system can activate the fresh air cooling system over the existing air conditioning whenever the ambient temperature and humidity conditions allow in order to realize a cost and energy savings over running the air conditioner. In some embodiments, the fresh air cooling system can be installed in a building as part of a new air conditioning installation. In such an installation, the integrated thermostat functions substantially the same as in installations retrofitted to function with existing air conditioning systems.

In some embodiments, the fresh air cooling system **102** can make control decisions based on interior and exterior atmospheric conditions provided by the internal and external temperature and/or humidity sensors. The typical operation of the system in a home that does not have air conditioning is for the thermostat **400** to turn on or off the whole house fans **104** depending on the desired temperature setting on the integrated thermostat **400**. If the integrated thermostat **400** calls for cooling, the thermostat **400** can determine whether the outside air temperature is cooler than the inside and then opens the damper **128** and turns on the fan **104** or fans. If the outside temperature is warmer than the internal temperature, the thermostat **400** does not activate the system **102** but can continue to monitor the situation periodically until the outside temperature is cool enough to be brought in effectively. In some embodiments, the thermostat **400** can be conditioned to control based on the measured humidity sensors.

In some embodiments, the thermostat **400** can control the air conditioner as well as the fresh air cooling system **102**. If the integrated thermostat **400** calls for cooling, the integrated thermostat **400** first can consider whether the fresh air cooling system **102** has the capacity to efficiently cool the house. The integrated thermostat **400** can be set to default to use the fresh air cooling system **102** whenever possible instead of the air conditioning system to provide a cost savings. If the integrated thermostat **400** determines that the fresh air cooling system **102** can effectively cool the building structure **100**, the thermostat **400** can activate the fresh air cooling system **102** until the desired temperature is reached. If, while the whole house fans **104** are running, the thermostat **400** determines that the fans **104** are providing inadequate cooling and cannot cool the house to the desired temperature, it can turn off the fans, can close the air intake **106**, can close the vents **114**, and can turn on the air conditioner. It then can continue to monitor the situation and can turn off the air conditioner and turn back on the whole house fans **104** when conditions are optimal for the fresh air cooling system **102**.

In some embodiments, the integrated thermostat **400** can include error correction features such that the air conditioning system cannot be turned on when the thermostat detects that the air intakes are open, the vents are open and the whole house fans are activated. Conversely, in some embodiments, the fresh air cooling system **102** will not activate when the thermostat **400** detects that the air conditioning system is activated. In some embodiments, the integrated thermostat **400** also will not allow the whole house fans **104** to activate unless the air intakes **106** and vents **114** are in their open positions.

In some embodiments, the recommended usage in the summer season is to turn on the fresh air cooling system **102** when the outside temperature is equal to or below the inside temperature and then keep them on until late in the evening to remove most of the latent heat that is in the structure and mass of the house and the attic **110**. In some embodiments, the system can be kept on until three hours after sunset. In some embodiments, the system can be kept on all night long. This method can prolong the cooling effects of the fresh air cooling system **102** into the subsequent day, thus reducing demand of the air conditioner. By following this procedure, a typical house in a desert climate zone, such as in the inland empire in southern California, may only require that the air conditioner be run for two to three hours per day instead of the normal 8 to 10 hours in the heat of the summer typically required by existing air conditioning systems. The fresh air cooling system **102** can require only a fraction of the energy of the air conditioning system, and therefore results in a significant energy and cost savings compared to traditional air conditioning systems.

Utilizing multiple air intakes **106**, the system **102** can be constructed with multiple zones whereby each air intake **106** can operate over different rooms or regions of the occupied space. When multiple air intakes **106** are used in conjunction with multiple thermostats, temperature sensors and/or humidity sensors, a user can activate different zones at different times to cool the home. Such a system allows for cooling of only the occupied rooms of the building structure therefore providing for more efficient cooling of the space and less energy consumption. Unoccupied rooms can be turned off or ignored by the control system.

Utilizing an automated air intake system in conjunction with the whole house fan **104** and vent system can enable intelligent air quality and comfort level control. The system can automatically determine when to open and close the intake **106** and vent **114** and turn on the whole house fan **104** when the exterior conditions permit cooling of the internal building structure. The user does not have to manually open windows to serve as air intakes and the building can be more effectively cooled with automated control. Additionally, the system **102** can operate when the user is away from the building. The thermostat **400** can open or close the damper **128** and ascertain that the fans **104** do not run until the damper **128** is open. At the same time, the damper's filters can clean all incoming air. Utilizing the fresh air cooling system **102** in conjunction with an air conditioning system can allow for an energy savings and a cost savings by reducing the demand of the air condition system. The integrated thermostat **400** can activate the fresh air cooling system **102** whenever the temperature and/or humidity sensors detect optimal cooling conditions. The user is not required to open the air intake **106** and the thermostat **400** can seamlessly switch between the fresh air cooling system **102** and an air conditioning system when present.

From the foregoing description, it will be appreciated that embodiments of an inventive cooling system are disclosed. While several components, techniques and aspects have been described with a certain degree of particularity, it is manifest that many changes can be made in the specific designs, constructions and methodology herein above described without departing from the spirit and scope of this disclosure.

Certain features that are described in this disclosure in the context of separate implementations can also be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation can also be implemented in multiple implementations separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations, one or more features from a claimed combination can, in some cases, be excised from the combination, and the combination may be claimed as any subcombination or variation of any subcombination.

Moreover, while methods may be depicted in the drawings or described in the specification in a particular order, such methods need not be performed in the particular order shown or in sequential order, and that all methods need not be performed, to achieve desirable results. Other methods that are not depicted or described can be incorporated in the example methods and processes. For example, one or more additional methods can be performed before, after, simultaneously, or between any of the described methods. Further, the methods may be rearranged or reordered in other implementations. Also, the separation of various system components in the implementations described above should not be understood as requiring such separation in all implementations, and it should be understood that the described components and systems can generally be integrated together in a single product or packaged into multiple products. Additionally, other implementations are within the scope of this disclosure.

Conditional language, such as "can," "could," "might," or "may," unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include or do not include, certain features, elements, and/or steps. Thus, such conditional language is not generally intended to imply that features, elements, and/or steps are in any way required for one or more embodiments.

Conjunctive language such as the phrase "at least one of X, Y, and Z," unless specifically stated otherwise, is otherwise understood with the context as used in general to convey that an item, term, etc. may be either X, Y, or Z. Thus, such conjunctive language is not generally intended to imply that certain embodiments require the presence of at least one of X, at least one of Y, and at least one of Z.

Language of degree used herein, such as the terms "approximately," "about," "generally," and "substantially" as used herein represent a value, amount, or characteristic close to the stated value, amount, or characteristic that still performs a desired function or achieves a desired result. For example, the terms "approximately", "about", "generally," and "substantially" may refer to an amount that is within less than or equal to 10% of, within less than or equal to 5% of, within less than or equal to 1% of, within less than or equal to 0.1% of, and within less than or equal to 0.01% of the stated amount.

Some embodiments have been described in connection with the accompanying drawings. The figures are drawn to scale, but such scale should not be limiting, since dimensions and proportions other than what are shown are contemplated and are within the scope of the disclosed inventions. Distances, angles, etc. are merely illustrative and do not necessarily bear an exact relationship to actual dimensions and layout of the devices illustrated. Components can be added, removed, and/or rearranged. Further, the disclosure herein of any particular feature, aspect, method, property, characteristic, quality, attribute, element, or the like in connection with various embodiments can be used in all other embodiments set forth herein. Additionally, it will be recognized that any methods described herein may be practiced using any device suitable for performing the recited steps. For example, some attics have not only sloping roofs, but also vertical walls that enclose the attic **110**. In attics that have a vertical wall or gable end, the vent **114** of the system according to certain embodiments of the present disclosure can also be placed in the vertical wall.

While a number of embodiments and variations thereof have been described in detail, other modifications and methods of using the same will be apparent to those of skill in the art. Accordingly, it should be understood that various applications, modifications, materials, and substitutions can be made of equivalents without departing from the unique and inventive disclosure herein or the scope of the claims.

What is claimed is:

**1**. A temperature regulating system for a building having a conditioned attic, the system comprising:

a whole house fan configured to operate at 200 to 4,000 revolutions per minute and to operate with a 500 to 8,000 cubic feet per minute capacity;

a vent comprising an inlet, an outlet, and a body portion disposed between the inlet and the outlet, the body portion adapted to provide a first airflow pathway between the inlet and the outlet, the first airflow pathway arranged to communicate between the conditioned attic and an air space outside of the building;

an air inlet adapted to provide a second airflow pathway that communicates between the conditioned attic and a living space of the building;

an air opening configured to be disposed on an outside wall of the building, the air opening adapted to provide a third airflow pathway that communicates between the air space outside of the building and the living space; and

an integrated thermostat configured to be in communication with the whole house fan and configured to turn on and off the whole house fan, the integrated thermostat configured to be coupled with a temperature sensor placed inside the building, the integrated thermostat configured to be coupled with a temperature sensor placed outside the building,

wherein the whole house fan is configured to be disposed within the vent and adapted to create, when the whole house fan is operating, a static negative pressure within the building that is sufficient to draw air from the air space outside of the building into the living space through the air opening,

wherein the first and third airflow pathways are configured to be independently controlled in a manner such that the airflow rate through the first airflow pathway can be adjusted so as to increase or reduce heat transfer between the conditioned attic and the air space outside of the building while the airflow rate through the third airflow pathway can remain unchanged,

wherein the integrated thermostat is configured to switch the system between a first airflow configuration and a second airflow configuration based at least in part on a temperature reading from the temperature sensor placed inside the building and a temperature reading from the temperature sensor placed outside the building, wherein in the first airflow configuration the first airflow pathway is closed and the third airflow pathway is open, wherein in the second airflow configuration the first airflow pathway is open and the third airflow pathway is open, and

wherein the integrated thermostat is configured to switch the system to a third airflow configuration and a fourth airflow configuration based at least in part on the temperature reading from the temperature sensor placed inside the building, wherein in the third airflow configuration the first airflow pathway is open and the third airflow pathway is closed, wherein in the fourth airflow configuration the first airflow pathway is open and the second airflow pathway is closed.

**2**. The system of claim **1**, wherein a volumetric flow rate of air through the vent is substantially equal to a volumetric flow rate of air through the air inlet.

**3**. The system of claim **1**, wherein the vent comprises a vent damper adapted to seal the inlet when the whole house fan is not operating.

**4**. The system of claim **2**, wherein the air inlet comprises an air inlet damper adapted to seal the air inlet when the whole house fan is not operating.

**5**. The system of claim **4**, wherein the air inlet damper comprises a plurality of blades that move to a closed position by gravity when the whole house fan is not operating.

**6**. The system of claim **1**, further comprising a cooling system.

**7**. The system of claim **1**, wherein the vent further comprises at least one mechanical damper, wherein the mechanical damper has an open configuration that allows air to flow through the vent, wherein the mechanical damper has a closed configuration that restricts air flow through the vent, and wherein the mechanical damper has an R-value of between R4 and R50 when the mechanical damper is in the closed configuration.

**8**. The system of claim **1**, wherein the whole house fan is disposed at least partially outside of a roof of the building.

**9**. The system of claim **3**, further comprising:

a motor that moves the vent damper to allow or block air flow through the vent.

**10**. The system of claim **9**, wherein the integrated thermostat controls operation of the motor.

**11**. The system of claim **1** further comprising:

a flange disposed on an outer surface of the body portion, the flange forming a substantially watertight seal with the body portion.

**12**. The system of claim **11** further comprising:

a cap disposed over the outlet of the vent, the cap being angled relative to the flange.

**13**. The system of claim **1**, wherein the integrated thermostat is configured to be activated remotely via a cellular telephone or a personal computer.

**14**. The system of claim **1**, wherein the integrated thermostat is configured to activate the whole house fan when, based on an external building temperature and an internal building temperature, the integrated thermostat determines the whole house fan can cool the building.

**15**. A temperature regulating system for a building having a conditioned attic, the system comprising:

a vent adapted to communicate between the conditioned attic and an environment outside of the building along a first airflow path;

an air inlet adapted to provide a second airflow path between the conditioned attic and a living space of the building;

at least one air opening adapted to provide a third airflow path between the environment outside of the building and the living space of the building;

a mechanical damper configured to be coupled to the at least one air opening and configured to control an airflow through the at least one air opening;

an integrated thermostat configured to control operation of the mechanical damper, the integrated thermostat configured to be in communication with a temperature sensor placed inside the building, the integrated thermostat configured to be in communication with a temperature sensor placed outside the building; and

a power ventilator configured to be disposed within the vent and adapted to exhaust to the environment outside of the building a volume of air drawn from the conditioned attic, the power ventilator having an airflow capacity sufficient to draw air from the living space into the conditioned attic through the air inlet when the power ventilator exhausts the volume of air drawn from the conditioned attic to the environment outside of the building, wherein the airflow capacity of the power ventilator is between 500 and 8000 cubic feet per minute,

wherein the first and third airflow paths are configured to be independently controlled in a manner such that the airflow rate through the first airflow path can be adjusted so as to increase or reduce heat transfer between the conditioned attic and the air space outside of the building while the airflow rate through the third airflow path can remain unchanged,

wherein the integrated thermostat is configured to switch the system between a first airflow configuration and a second airflow configuration based at least in part on a temperature reading from the temperature sensor placed inside the building and a temperature reading from the temperature sensor placed outside the building, wherein in the first airflow configuration the first airflow path is closed and the third airflow path is open, wherein in the second airflow configuration the first airflow path is open and the third airflow path is open,

wherein the integrated thermostat is configured to switch the system to a third airflow configuration and a fourth airflow configuration based at least in part on the temperature reading from the temperature sensor placed inside the building, wherein in the third airflow configuration the first airflow path is open and the third airflow path is closed, wherein in the fourth airflow configuration the first airflow path is open and the second airflow path is closed.

16. The system of claim 15, wherein the mechanical damper further comprises a switch sensor adapted to indicate a position of the mechanical damper.

17. The system of claim 16, wherein the switch sensor communicates with the integrated thermostat to inform the integrated thermostat of a position of the mechanical damper.

18. A temperature regulating system for a building having an attic, the system comprising:

a whole house fan configured to operate at 200 to 4,000 revolutions per minute and to operate with a 500 to 8,000 cubic feet per minute capacity;

a vent comprising an inlet, an outlet, and a body portion disposed between the inlet and the outlet, the body portion adapted to provide a first airflow pathway between the inlet and the outlet, the first airflow pathway arranged to communicate between the attic and an air space outside of the building;

an air inlet adapted to provide a second airflow pathway that communicates between the attic and a living space of the building;

an air opening configured to be disposed on an outside wall of the building, the air opening adapted to provide a third airflow pathway that communicates between the air space outside of the building and the living space; and

an integrated thermostat configured to be in communication with the whole house fan and configured to turn on and off the whole house fan, the integrated thermostat configured to be in communication with a temperature sensor placed inside the building, the integrated thermostat configured to be in communication with a temperature sensor placed outside the building,

wherein the whole house fan is configured to be disposed within the vent and adapted to create a static negative pressure within the building that is sufficient to draw air from the air space outside of the building into the living space through the air opening;

wherein the first and third airflow pathways are configured to be independently controlled in a manner such that the airflow rate through the first airflow pathway can be adjusted so as to increase or reduce heat transfer between the attic and the air space outside of the building,

wherein the integrated thermostat is configured to switch the system to a first airflow configuration and a second airflow configuration based at least in part on a temperature reading from the temperature sensor placed inside the building and a temperature reading from the temperature sensor placed outside the building, wherein in the first airflow configuration the first airflow pathway is closed and the third airflow pathway is open, wherein in the second airflow configuration the first airflow pathway is open and the third airflow pathway is open, and

wherein the integrated thermostat is configured to switch the system to a third airflow configuration based at least in part on the temperature reading from the temperature sensor placed inside the building, wherein in the third airflow configuration the second airflow pathway is closed.

19. The system of claim 18, wherein the integrated thermostat is configured to switch the system to a fourth airflow configuration based at least in part on the temperature reading from the temperature sensor placed inside the building, wherein in the fourth airflow configuration the first airflow pathway is open and the third airflow pathway is closed.

20. The system of claim 18, wherein in the third airflow configuration the first airflow pathway is open.

21. The system of claim 18, wherein the integrated thermostat is configured to switch the system to a fifth airflow configuration based at least in part on the temperature reading from the temperature sensor placed inside the building, wherein in the fifth airflow configuration the first airflow pathway is closed.

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